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Controlling Water on the Land ..... E. N. Munns, and Leon Lassen

Drainage in Conservation Farming ..... T. W. Edminster, J. P. Walker and J. H. Lillard

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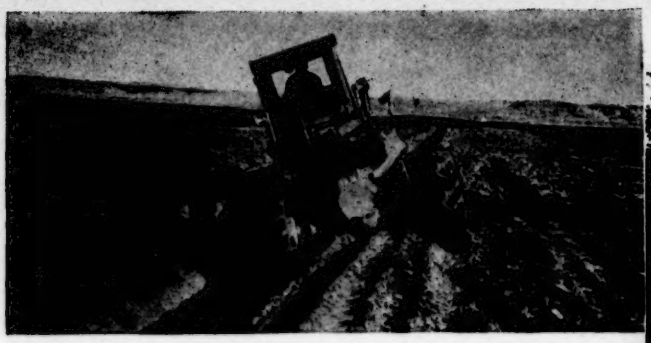
Ditches to Cut



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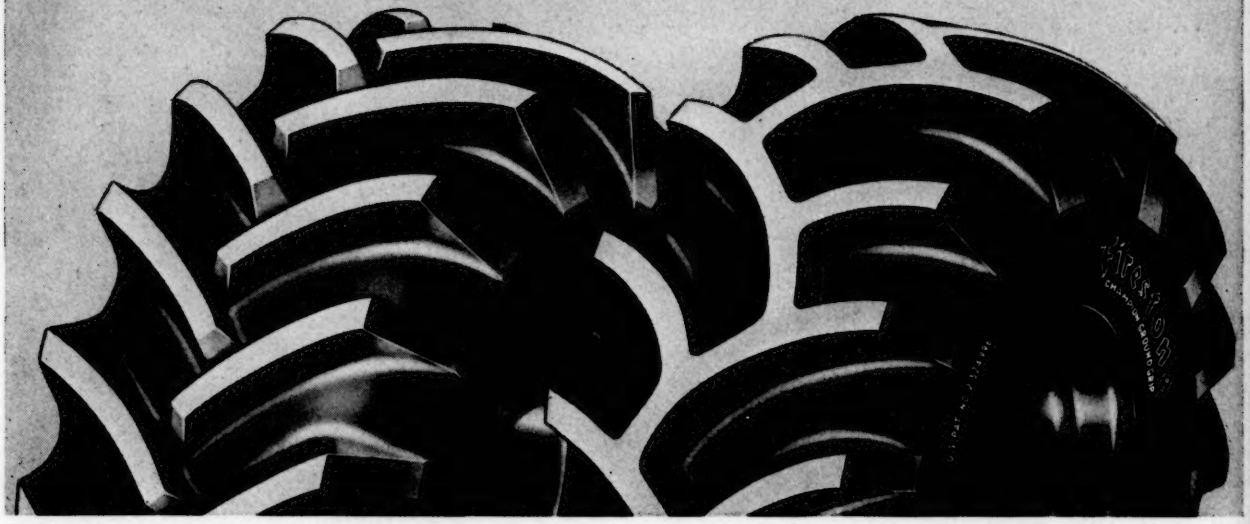

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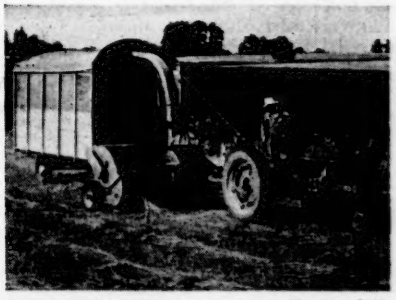

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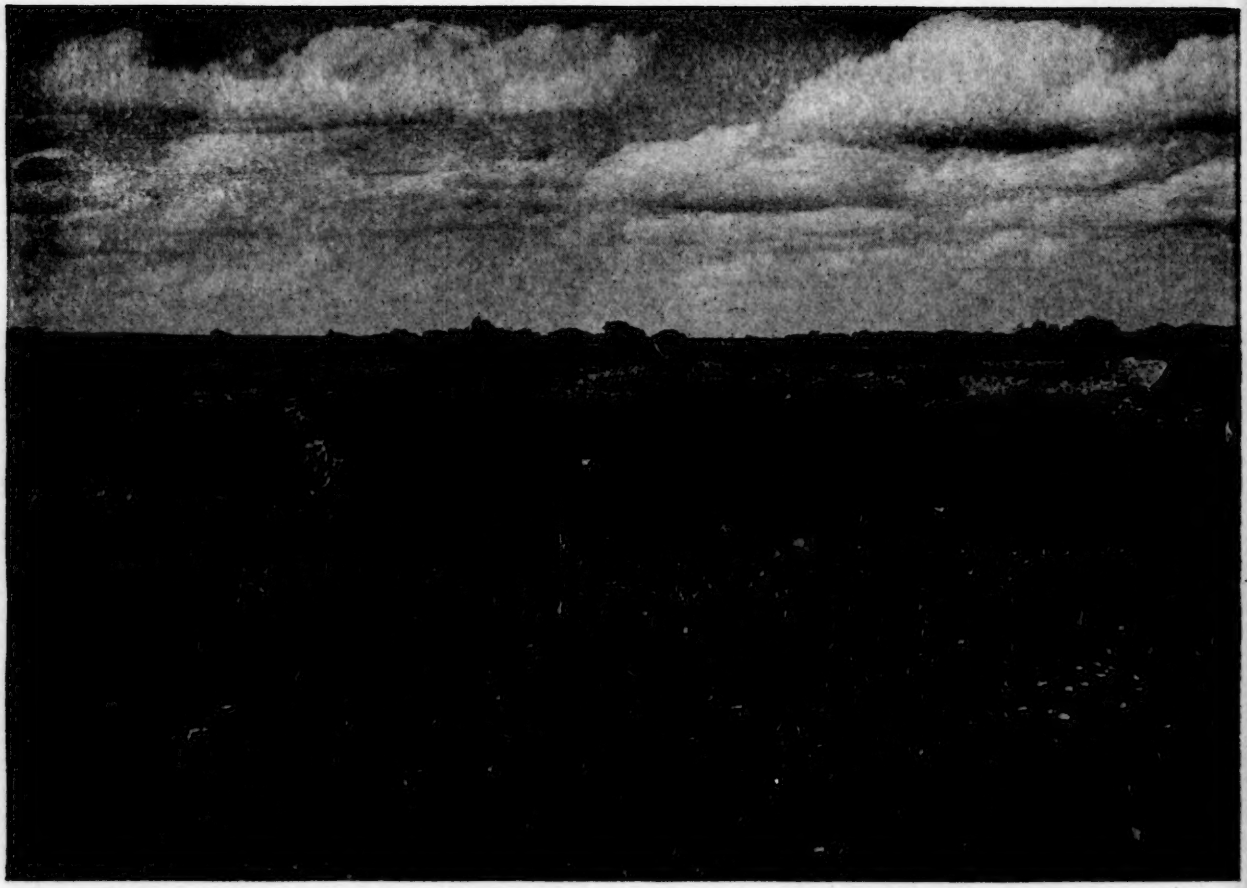

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Conservation—A Brief Appraisal

PAUL B. SEARS

Conservation is fundamentally an attitude rather than being simply another technique. Yet that attitude, according to Dr. Sears, must assuredly employ techniques and direct their use if it is to find effective expression. Of the many facets of our present culture, science and private enterprise bear a vital relationship.

To make conservation effective, technologists must have the kind of scientific training which will enable them to grasp the world of nature in its entirety. Private enterprise, on the other hand, has the responsibility for the preservation of our capital structure in terms of natural resouces.

IT IS IMPORTANT to remind ourselves that much of the best conservation is older than science, and that even today technical knowledge is seldom the limiting factor in our wise use of natural resources. I recently saw the collection of aerial photographs taken by the 37th Division for its advance from Manilla to Baguio. These photographs show amazingly perfect terraces developed on steep hillsides, with minimum injury to the surrounding tropical forests. This was the work of so-called primitive people. And in Mexico I have examined small remnants of good land use practice which long antedate the Conquest. These remnants may fairly be called living fossils of sound cultural adjustment which have somehow withstood the impact of modern exploitation.

I would by no means underestimate the very real progress of the past twenty years in the United States. Public opinion has been aroused, and public support organized to a degree that would have seemed fantastic and hopeless in 1930. Sportsmen, for example, who have had to put up much of the cold cash for conservation, have been literally reeducated and are now seeing their particular problem as merely an aspect of wise land use. Finance and industry are stepping into the picture and lending substantial support not only to the conservation of their own raw materials, but to more general enterprises. School administrators are waking up and the next Yearbook of their national organization will deal with conservation education. I could continue for some time with such optimistic reports.

Conservation—a Moral and Social Problem

Is there any reason, therefore, why we should not use our time here in mutual self-congratulation and return to our tasks refreshed for simply carrying on as we have begun, with more vigor than ever? I wish it were possible, but I doubt it. For it seems to me that, in any fundamental sense, we have barely scratched the surface.

I mention the good conservation of prescientific days not to discount the importance of science, but to emphasize the fact that conservation is basically a moral and social problem. Here science has two really great contributions to make. First of all it must give mankind a realistic notion of the kind of universe in which we live. Throughout human history conduct and the values which regulate it shape themselves according to the kind of world in which men believe themselves to be. The second great role of science is to give us the technical means to carry out the implications of our fundamental beliefs.

A much less important function of science (desirable though it may be) is to lift the physical burdens from the shoulders of humanity and to provide comfort and diversion. And finally the prostitution of science is to employ it in destruction, by marshalling natural resources for wars that can by any possibility be averted.

If I am correct in these assumptions, certain conclusions follow as a matter of course. The scientific interpretation of the universe pictures it as the expression of universal law, which plays no favorites. Conservation of energy and matter are at the very basis of this great system. *The science of ecology sees living communities and the soil which sustains them as capable of building up to a thermodynamic steady state, whose organization permits the maximum efficiency in the use of solar energy and inorganic materials to support life. And it sees that man, on a wide scale, has interrupted the course of this development without substituting its equivalent.*

This being so, it is fair to ask: Do we act as though we believed it? Does our scheme of values really impose any obligation, any emotional sanction, to act as though this were true? If the sense of obligation does exist, it can be phrased very simply. The Pennsylvania Dutch farmer, who never heard of thermodynamics, expresses the principle very plainly: "*I want the boy to get this farm as good as I got it.*" With him this is a matter of principle, of ingrained obligation.

This paper by Dr. Paul B. Sears, Head of the Botany Department at Oberlin College, Oberlin, Ohio, was presented at the Annual Meeting of the Soil Conservation Society of America held in St. Louis, Missouri, November, 10-12, 1949.

Dr. Sears is one of America's best known botanists and the author of several stimulating books of general interest including *Deserts on the March.*

We cannot go back to the simplicity of the Chinese peasant, the ancient Peruvian terrace maker, or the old Amishman. Our problem is far more complex. Ultimately it is a problem of artistic insight and spiritual leadership. But I think we can lead most promptly to these goals by making the American people scientifically literate.

Let me be very explicit on this point. A man can be in the very forefront of a scientific field and still not be scientifically literate. I could name one such individual, of great influence but utterly ignorant of biological processes. He actually believes that all conservation talk is nonsense, and that whenever the situation gets really serious he and his kind will come up with a new solution.

To counter such misbelief, I think we must learn that true science instruction must begin with the very earliest education. Words must be learned, not in vacuum, but in relation to the objects and processes which they symbolize. And our science teaching at higher levels must be drastically overhauled. Survey courses were an attempt in the right direction, but they failed because they left out or slighted the physical experiences with the world of nature which are essential to scientific literacy. We call this experience laboratory work, but the average elementary college laboratory is at present hardly a place for valid experience, let alone adventure and discovery.

Most college instruction in science is frankly shaped to the imagined needs of the future specialist—less than ten per cent of the whole student group. Once we can send out future professional men, business and industrial leaders, poets, artists and writers, who sense in their very bones the universal character of scientific law, I believe they will quickly enough begin to shape our culture to fit that conception.

Granting this as possible, there remain tremendous obstacles in the way. Our civilization as it is—even in this world revolution that is going on—has tremendous inertia and will be hard to modify. We have been applying science most powerfully to two ends that are certainly not conservative. One is the elaboration of consumers' goods, with attendant marketing pressure and without much reference to raw materials. The other is the related problem of making war munitions. These applications are out of all proportion to other uses of science, even medical science. You may have noticed that Billy Rose was shocked at the salaries available for research workers on poliomyelitis and cancer. The distributary flow of money is not a complete measure of the aims of a culture, but it is pretty significant.

The era of ugly architecture in the United States coincided with the rape of the white pine forests of Michigan and Wisconsin. This was accompanied by a tremendous sales promotion campaign in which free plans were given out showing how to use wooden gingerbread in the most extravagant manner possible and appealing to customer vanity in thoroughly modern fashion.

That sales promotion has done much to raise the standard of living I do not question. But the mere possession of consumers' goods is a matter of rapidly diminishing returns and is no guarantee of human happiness. I do not envy the situation of big industry whose employees strike for higher wages partly because they can read the clever advertisements of big industry. I know that extravagant use of such things which are not necessary is pretty tough on natural resources.

Nor do I have any quick remedy for this unbalance. I should, however, like to see thrift encouraged by something more inviting than a bleak box ad of the local savings bank, "1% interest on time deposits." I should like to see, too, more statesmanship on the part of leaders in labor, finance, and industry—more concern with general welfare than is now visible to the naked eye. And I question whether we shall ever have anything like a stable economic system until men who work at machines can feel that they have a definite stake in the game. These are my judgments as a conservative who is interested in the problem of conservation.

Finally, we have the supremely horrible problem of war, the effects of which, so far as natural resources are concerned, I need not elaborate. Nor shall I discuss the current, deadly international poker game, except to point out that Great Britan has lost her great role as a stabilizer, not because of any political doctrines but because she has become a nation without resources.

Instead I wish merely to point out that, in our own desperate economic plight of the 1930's, we relied heavily on restoring international trade. And aside from scrap iron, oil, and phosphates, we did a tremendous business in selling machine tools to Germany, Russia, and Japan. Machine tools are the real armaments of war. During that period one American company lifted a million dollar deficit, with Japan as its best customer. Another sold to Russia and Germany. I have been told on good authority that these transactions were financed by both British and American capital. You all know what the ensuing war did to our oil, timber, and iron reserves.

I have tried, in the foregoing sketch, to show first that conservation is fundamentally an attitude rather than being simply another technique. Yet that attitude must assuredly employ techniques and direct their use if it is to find effective expression. Of the manifold facets of our present culture, I have selected two for their vital

(*Continued on page* 85)

Ecological Bases for Land Use Planning in Gulf Coast Marshlands

PHILIP F. ALLAN

There is a lot of talk by conservationists these days about the "dynamic point of view." The following article by Allan is a concrete example of such a viewpoint. It clearly illustrates the fact that a knowledge of the existing condition of the land is not enough for the land manager, who must also know the process or developmental trend the existing condition represents. This principle is of primary importance to all technicians dealing with native vegetation, whether marsh, range, or forest. Allan's article is a first-rate example of the kind of interpretative analysis, based on an intimate knowledge of field conditions, that is required if the best use of wild lands is to be achieved. It illustrates also the kind of contribution the biologist can make to land management.

A KNOWLEDE OF THE DYNAMICS of plant ecology, and the ability to recognize the various stages of primary and secondary succession provide the only sound basis upon which may be founded land uses involving wild or cultivated plants. Such knowledge also may explain our failures with such plants.

In Gulf Coast marshlands numerous perplexing problems of land use can be solved once the significance of successional trends is understood. There is an amazing uniformity of stages in marsh succession from Nova Scotia to Mexico. The presence of water is the great equalizer—far outweighing the limitations of climate. But the presence of salt is the great limiter. Thus, where primary succession has taken place, we find repeatedly along the Gulf Coast (Penfound and Hathaway, 1938) —as well as the East Coast (Ganong, 1903; Johnson and York, 1915; Harshberger, 1909; Wells, 1928)—the same dominant plant species occupying the same relative position with respect to water table and salinity levels (Figure 1).

Since we are not concerned with submerged or floating plant stages of succession, but with the true marsh, it is unnecessary to describe those stages. Only the major elements of marsh communities are considered in the following discussion, because it is from a knowledge of the more important communities that we may plan practical conservation land uses.

There are two basic types of coastal marsh plant succession—that of the salt marshes and that of the fresh. Fresh marshes are characterized by having salinity levels of free soil moisture less on the average than 1.0 percent. From 1.0 percent to 5.0 percent salinity is typical of salt marsh succession. Such inexact terms as "brackish" tend to confuse rather than clarify our knowledge of basic succession.

Two phases of coastal succession can be recognized. The eastern phase reaches its climax in Deciduous Forest and extends from the Atlantic Coast westward to the vicinity of the 40-inch rainfall line. The western phase reaches its climax in the Coastal Prairie aspect of the True Prairie. From the vicinity of Rockport, Texas, southward the marshes commonly are constricted because of elevated land nearly to the water's edge. Locally several stages of succession may be found in as little as 20 feet horizontal distance. On the other hand the low rainfall, which causes little leaching of salts from the soil, has permitted the persistence of relict areas of such salt marsh plants as Gulf cordgrass as far inland as Pleasanton, Texas. From the vicinity of Trinity Bay, Texas, eastward to Lake Charles, Louisiana, there is an area of preclimax prairie inclusions.

SALT MARSHES

First Stage of Salt Marsh Succession

Characteristics: First, where salinities range from 3.0 to 5.0 percent and the average water table is four inches above ground level (Figure 2), the site is characterized by the dominance of Smooth cordgrass (*Spartina alterniflora*). At this stage (Saltcane Marsh) plants may be inundated with salt water for as much as 20 hours per day. Figure Unlike most other marsh plants, the tolerance of Smooth cordgrass to salinity is in direct proportion to water depth.

Uses: Smooth cordgrass seems to be of little value for livestock forage although it is sometimes eaten after rains, when salts accumulated on the surface of the

Philip F. Allan is Regional Biologist for the Soil Conservation Service Gulf Coast Region, with headquarters at Ft. Worth, Texas. He has had long experience with practical phases of the biology of land use, and is a recognized ecologist. He is the author of numerous papers on furbearers, marshland management, and other wildlife phases of soil and water conservation. He is an outstanding "land management biologist."

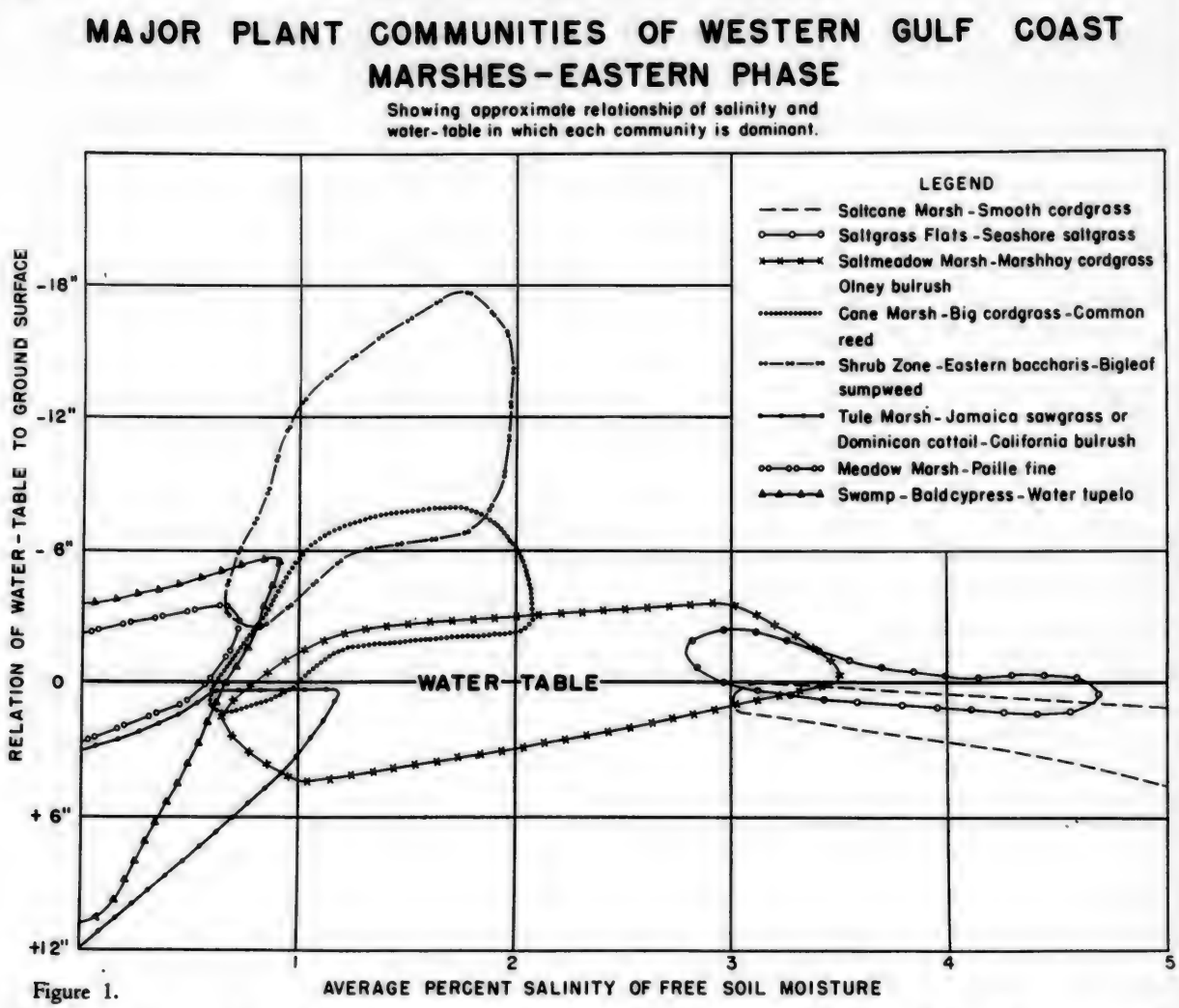

Figure 1.

plants have been washed away. The site ordinarily is too wet for practical livestock grazing. Smooth cordgrass is considered a valuable food plant for geese (Martin and Uhler, 1939) and is of limited value for muskrats (Arthur, 1931). Under disturbance by grazing or burning, Needlegrass rush (*Juncus roemerianus*), a plant of somewhat limited livestock and wildlife value, is the most prominent "increaser." On drier portions continued disturbance permits the invasion of Seashore saltgrass (*Distichlis spicata*).

The salinity and wetness of the first stage of succession render it obviously unsuited for tillage and livestock grazing. Disturbances, such as burning, tend to make it less suitable for wildlife, for which in its natural state it is best adapted.

Second Stage of Salt Marsh Succession

Characteristics: The second stage of salt marsh succession is characterized principally by the dominance of Seashore saltgrass (Saltgrass Flats). This stage usually is quite restricted in extent (Figure 3). Salinities range from 3.0 to 4.6 percent and average water tables are between plus two and minus two inches. Although saltgrass has a much wider range of tolerance for freshness of water than the above figures indicate, it does not occur as a dominant of primary succession beyond the limits given.

Uses: Since the community is relatively unimportant both in extent and in value to livestock or wildlife its use for practical purposes would be coincidental to the uses of adjoining communities.

Third Stage of Salt Marsh Succession

Characteristics: From the standpoint of safe and practical use the third stage (Saltmeadow Marsh) of salt marsh succession is one of the most important. It is extensive in area and is characterized by a wide range of salinity and water levels. Marshhay cordgrass (*Spartina*

patens) is the principal dominant (Figure 4). The salinity ranges from 0.75 to 3.5 percent, and water levels range from plus four to minus four inches. In fresher portions (0.80 to 1.75 percent salinity) and where water levels are from plus four to minus one inches the Olney bulrush (*Scirpus olneyi*) is a co-dominant. Needlegrass rush is the most important subdominant in the more saline areas. Seashore saltgrass also is found as a common secondary species.

Two major edaphic conditions are found in marshes where Marshhay cordgrass is the dominant species. In some localities this stage occurs on deposits of peat of varying depths where old lakes, bayous, and bays have become filled with plant remains. Elsewhere the stage of succession is found on mineral soils of outwash material or soils deposited by tidal and wave action.

Uses: Lands having this stage of salt marsh succession have been put to three principal uses—all of them more or less incompatible with each other. Intensive cropland developments—mainly for the production of sugarcane and rice—have been established on peat soils. Large, expensive levee and pumping systems have been installed. Rapid shrinkage of the soil accompanies drying and oxidation of the peat, often to a point where the surface is several feet below sea level. The pH falls quickly, sometimes to as low as 3.5. Crop yields—spectacular at first—quickly decline, especially in rice culture. Liming, deep plowing and sand spreading have been resorted to, with indifferent success. There has been considerable abandonment of cropping and a conversion of the land to pasture. A number of such agricultural enterprises have completely failed. Despite the successes of the Netherlands in reclaiming lands of this nature we have not found it economical, nor do we know enough about management of these lands to use them wisely for crop production.

For practical purposes the Marshhay cordgrass marsh —as well as the succeeding stage dominated by Big cordgrass and Common reed—may be considered edaphic grassland climaxes. Therefore, under certain conditions, they may be safely and practically used for the grazing of livestock. Let us dispose for the moment of the deep

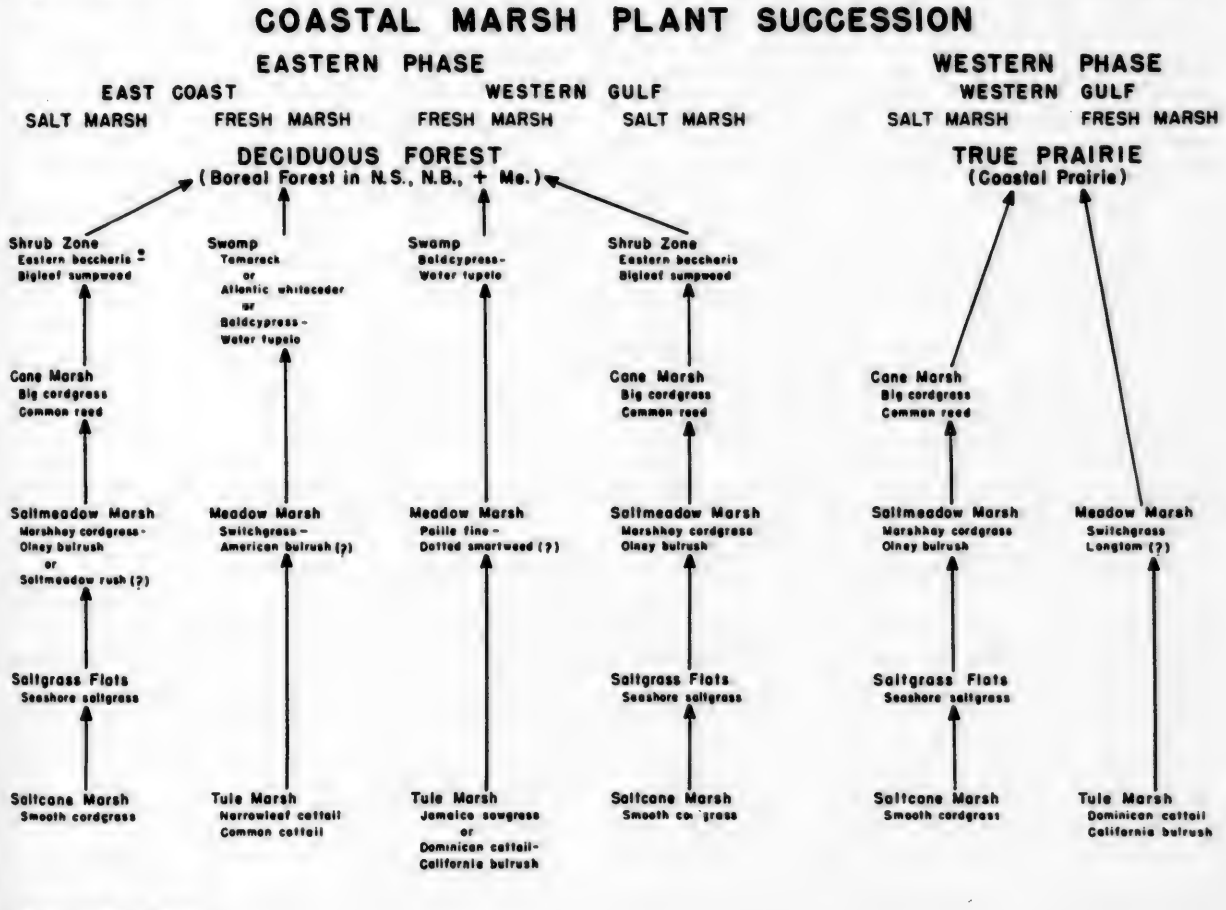

Figure 2.

peat portions of the marsh as unsuitable for livestock because of seasonal limitations, insect and parasite pestilences, the bogging of cattle and the general wetness of the site and consider the mineral marsh from the standpoint of range.

Modern range management is based primarily on a knowledge of plant succession and its main objective is, with minor exceptions, the management of livestock in a manner designed to maintain grasslands at or near climax condition. Numerous studies have shown that climax grasses are generally preferred by, and produce the most profit per acre from, livestock.

The composition of vegetation—varying of course by sites—forms the basis for classification of range condition. Thus, if 75% to 100% of the composition of plants on a range is comprised of climax species the range is classified as "Excellent." All of the climax species present on ranges in lower condition are allowed as credits in arriving at range condition. If the percentage of climax species falls between 50% and 75% the range is considered "Good"; if it is between 25% and 50% it is "Fair"; and between 0 and 25% it is "Poor."

In actual observation we find that Marshhay cordgrass and Olney bulrush, on Saltmeadow Marsh, are the first to disappear under overgrazing. They are replaced to a large extent temporarily by Needlegrass rush, Seashore saltgrass, and Seashore paspalum (*Paspalum vaginatum*). Finally these are replaced by a variety of annuals and unpalatable forbs.

Relict areas at the present are few, and most of this kind of marsh has been overgrazed to the point where it bears little resemblance to "climax" conditions. The practice of uncontrolled burning has caused further retrogression. Burning usually takes place at a period when plants are storing food. It is followed by grazing of the tender fall growth, and the new spring shoots of seedlings are taken before cattle are removed from the marshes. Although improved range could be attained through known methods of management, I know of no instance along the Gulf Coast marshland where it has been done.

The principal wildlife habitat of salt marshes is found in this stage of succession. These lands are the main producers of muskrats, mink, otters and alligators. Under "climax" conditions they are of little value to waterfowl, but provide homes for a host of marsh and song birds and other wildlife species.

Where peat soils underlie the vegetation there is little question that wildlife production is the most practical and valuable use of the land. For muskrat production, measures that favor Olney bulrush at the expense of Marshhay cordgrass are required. Since both of these are co-dominants in the salinity and water table ranges that are optimum for the bulrush, management is a rather delicate process. Controlled burning of marshes seems to be the principal means of developing stands of Olney bulrush. Burning the marsh every second spring when there is sufficient water to prevent damage to rootstocks has been found by Lay and O'Neil (1942) to accomplish desired results. Unfortunately, overgrazing of the bulrush by muskrats and geese may favor the quick return of Marshhay cordgrass. But if the overgrazing is severe enough the area becomes covered with Needlegrass rush, saltgrass, and annual invaders.

Beyond the maximum salinity range of Olney bulrush, water control measures designed to pond fresh water, either from rainfall or drainage, are needed. Inundations of salt water must be removed as quickly as possible. The reverse, of course, is required at the lower limits of salinity tolerance. Here drainage of fresh water and irrigation with salt water are needed. Numerous areas formerly productive of muskrats have been converted to a fresh water marsh type of succession through the practice of outletting onto the marsh drainage systems from the uplands. Levees and roadways have permitted the excessive ponding of fresh water, thus damaging the marshes.

Continuous grazing of livestock during the winter months in muskrat marshes does not permit satisfactory management of the fur bearers. It may be possible, however, to utilize livestock to improve such marshes. Marshhay cordgrass flowers in the fall and spring. Heavy grazing during the flowering period exerts a repressive effect upon grasses. During the winter, Olney bulrush makes a new sprout growth. Grazing at this period also is deleterious. By concentrating cattle on low marshes during October and November and then moving them to other pastures for the succeeding four months it should be possible to favor Olney bulrush. The marsh may be divided into two pastures of one-third and two-thirds each, or into three equal pastures. The more favorable area for muskrats should be grazed in October and November at the rate of about one acre per animal. The remainder of the grazing period is used on the other two-thirds of the land.

The main objective in providing wintering grounds for waterfowl is the production of the greatest quantity and variety of seed-bearing forbs and succulent annual plants. It is attained by instituting secondary plant succession and maintaining early stages. Thus, the management of third stage marshes for this purpose requires deliberate overgrazing by livestock and may also require intensive burning. This, of course, is not good livestock management.

The owner of third stage marshes on mineral soils must decide whether to use them for livestock, fur bearers, or waterfowl. If he wishes to use them for livestock or fur bearers he must manage the vegetation in a man-

Figure 3. The first two stages of salt marsh succession. *Background*—Saltcane Marsh; *foreground*—Saltgrass Flats.

ner that will keep it at or near the "climax." If he wishes to manage it for waterfowl he must establish a secondary succession and thereby maintain annual plants and seed-bearing forbs.

Fourth Stage of Salt Marsh Succession

Characteristics: The fourth, and final stage, of salt marsh succession (Cane Marsh) is characterized by the dominance of Big cordgrass (*Spartina cynosuroides*) and Common reed (*Phragmaites communis*) (Figure 4). Gulf cordgrass (*Spartina spartinae*) is the most important secondary grass. Salinities range from about 0.60 percent to about 2.1 percent. The water table, except at the fresher end of the salinity range is from 4 to 8 inches below the ground surface. In areas where the salinity is a little under 1.0 percent this stage may be found in water 2 or 3 inches deep. There is, therefore, an inverse relation between salinity and water table which renders the habitat physiologically xeric to the vegetation.

Uses: Wherever the fourth stage occurs in considerable area it is almost always used as range for livestock. This stage, as in the preceding one, can be considered an edaphic grassland climax.

With a decline in the co-dominants as a result of overgrazing, Gulf cordgrass, Eastern baccharis (*Baccharis halimifolia*), and Bigleaf sumpweed (*Iva frutescens*) increase. These plants are quite persistent, but they ultimately decline, and are replaced by Bagpod (*Glottidium vesicarium*), annual grasses such as Annual bluegrass (*Poa annua*), and annual forbs.

It is about as difficult to find relict areas of fourth stage marsh as it is for the preceding stage. Range condition for cane marsh must be based mainly upon Big cordgrass and Common reed, with recognition that Gulf cordgrass, Eastern baccharis and Bigleaf sumpweed are minor elements of the "climax."

Fourth stage marshes are of little value for fur bearers, although occasionally by flooding they may be developed into suitable habitats. The objective would be the establishment of conditions representative of the third stage of succession.

As in the case of third stage salt marshes the development of waterfowl habitat depends upon deliberate overgrazing by livestock and, possibly, the use of fire. Greater care, however, must be exercised in order to prevent the increase of baccharis, and sumpweed and the invasion of Bagpod.

At the fresher end of the salinity range for Big cordgrass and Common reed portions of the marsh on mineral soils may be drained for cultivation or pastures. Soil conserving measures are needed for either of these uses. If cane is grown a 12-year rotation is used: 3 years cane, 3 years pasture, 2 years legume cover crop, 3 years cane, and 1 year cover crop. When land is used for rice a 3- or 5-year rotation of rice and pasture is used. The use of drained land for permanent pasture involves fertilizing, liming, weed mowing, the establishment of perennial base grasses and legumes, and deferred and rotated grazing.

SHRUB ECOTONE

Succeeding the fourth stage of salt marsh succession in the eastern phase there is a shrub ecotone (Shrub Zone) in which Eastern baccharis and Bigleaf sumpweed are the dominants. Usually, under natural conditions, this stage is restricted in area. Drainage, unaccompanied by management of the land, sometimes creates extensive areas of baccharis and sumpweed. The ecotone is suc-

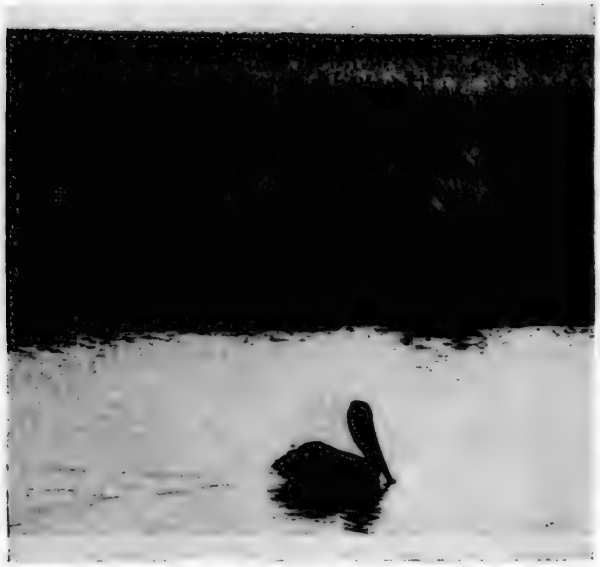

Figure 4. The third and fourth stages of saltmarsh succession. *Foreground*—Saltmeadow Marsh; *background*—Cane Marsh.

ceeded by deciduous upland hardwoods. In the western phase the fourth, and often the third, stage of salt marsh succession is followed by wet prairie dominated by Switchgrass (*Panicum virgatum*), Seacoast bluestem (*Andropogon littoralis*), Little bluestem (*Andropogon scoparius*), Big bluestem (*Andropogon furcatus*), Bushy bluestem (*Andropogon glomeratus*), various paspalums, and Eastern gamagrass (*Tripsacum dactyloides*). We have, at this point, departed from true marsh conditions—and, hence, from the situation under consideration in this paper.

FRESH MARSHES

Fresh water marsh succession along the coast differs in several respects from that of salt marsh. There is, for example, only a single stage dominated by a grass. That stage, moreover, is rather evanescent and occupies quite a narrow range of site conditions.

In general, fresh marshes have higher average water tables than do salt marshes. They occur in more inland locations, except where flooding or ponding of fresh water has occurred in the salt marsh.

First Stage of Fresh Marsh Succession

Characteristics: The first stage of fresh marsh (Tule Marsh) may be dominated by Dominican cattail (*Typha domingensis*), usually with California bulrush (*Scirpus californicus*) as a co-dominant. In some localities east of Trinity Bay, however, practically pure stands of Jamaica sawgrass (*Mariscus jamaicensis*) characterize this stage of succession. This plant is somewhat more limited by salinity than are the other two species (up to about 0.75 percent salinity). Water tables in this stage of the fresh marsh range from 0 to plus 12 inches. Salinity ranges from 0 to slightly more than 1.0 percent.

Uses: The depth of water and character of the vegetation render these marshes unsuitable for sound livestock management. In general, also, there is too much water to be removed to make drainage for cropland or pasture land use feasible; although occasionally satisfactory outlet systems may be built.

Cattail and sawgrass marshes are of relatively little value for muskrat production along the Gulf Coast. In some instances it is possible to provide facilities for the drainage of fresh water and irrigation with salt water, and thus convert fresh marshes to suitable salt marshes.

Alligators, otters, and the recently established nutria occur in considerable numbers in cattail and sawgrass marshes. At present, however, too little is known about the ecology of these creatures to permit statements about land or water management measures for their benefit. It seems likely that non-draining channels that would provide access to unoccupied areas of the marsh might prove useful to all three species. But perhaps the best that can be done to such marshes may be to leave them alone.

In an undisturbed condition marshes in this stage are only fair waterfowl habitats. It is, perhaps, in the field of waterfowl management that fresh marshes can be put to the best use. Deliberate overgrazing and burning appear to be the measures needed to improve fresh marshes for waterfowl. It is by such means that Bulltongue arrowhead (*Sagittari lancifolia*), Delta arrowhead (*Sagittaria platyphylla*), Dotted smartweed (*Polygonum punctatum*), and other waterfowl foods are increased. The development of ponds, either by building levees or by excavation, may be feasible for private landowners where waterfowl hunting may be leased.

Second Stage of Fresh Marsh Succession

Characteristics: Succeeding cattails or sawgrass in the eastern phase is a stage (Meadow Marsh) composed primarily of Paille fine (*Panicum hemitomon*). To the westward Switchgrass characterizes this stage. These are highly palatable and nutritious grasses for livestock and in most localities have been badly overgrazed.

Uses: In managing such marshes for livestock, measures designed to maintain a plant composition of 75 to 100 percent *Panicum* species are needed.

Paille fine marshes offer possibilities for hay or ensilage production. With careful drainage and management they may be developed into tame pastures. The lack of suitable sites for drainage outlets limits the possibility of draining such marshes for use as croplands. They appear to be of little use for game or fur bearers.

(*Continued on page 85*)

Some European Soil Conservation Problems

A. T. SEMPLE

European Governments are faced with grave and difficult problems that may interfere with the development of an adequate soil conservation program, regardless of its urgent necessity and extreme importance. This informative article by Semple highlights the agricultural and land use conditions in each of the major European countries that were represented at a conference held in Florence, Italy, about a year ago. A number of significant guides for immediate action in the general field of soil conservation are also suggested.

IN SPITE OF THE MODERATE nature of the rainfall, and the relatively high crop yields common to most parts of Europe, it has soil conservation problems quite as difficult as those of other continents, where soil wastage is more spectacular and has been given much more publicity. However, the cold winters and moderate summer temperatures in most parts of Europe make it possible to maintain more organic matter in the soil, thereby increasing its water-holding capacity and reducing its erodability. Furthermore, most of the farmers of Europe have learned well the ways of holding their soil in place and making it produce the maximum yields under their conditions. By long hours and careful hand work they obtain maximum yields per hectare rather than maximum production per man.

In Belgium, for example, with almost 9,000,000 people living on a territory slightly larger than 30,000 square kilometers (11,583 square miles), there is an extreme intensity of crop and livestock production. The area so utilized is 1,745,004 hectares (4, 314,500 acres) of which 778,000 hectares (1,922,500 acres) are pasture. In lower and middle Belgium, industry and agriculture compete keenly with each other for ground.

Small farms, intensively cultivated, utilize large quantities of chemical fertilizers. Soil erosion is practically nonexistent. The maritime climate with only moderately intensive and well-distributed rainfall—600 to 1,000 mm. (24 to 40 inches)—and the small fields often enclosed by hedges or rows of trees are not conducive to the carrying away of the soil. The common use of pasture leys is a big factor in effecting a minimum of soil loss. It is really only at certain rare points in La Hesbaye that one still sees soil erosion. There, where the stratum of very fertile soil lies in the form of a thin layer over the sand, one can sometimes see it being carried away as a result of violent summer rains with the consequent exposure of the sandy subsoil.

Likewise in the Netherlands, there are only about 2,400,000 hectares (6,000,000 acres) of agricultural land to support approximately 10,000,000 people. Furthermore, the national economy depends upon the exportation of large quantities of certain agricultural products. This is possible in spite of the fact that 50 percent of the agricultural land of Holland is very sandy and poor in natural fertility. To correct this condition the Dutch farmers are continuing to make intensive use of chemical fertilizers. During the present year, the average use per hectare for all the cultivated land is estimated to be 350 kilograms of which nitrogen, phosphorus and potash make up approximately equal parts (312 pounds per acre). In other countries, such as Italy where the population pressure is also great in relation to agricultural land, and a severe shortage of food exists, the use of chemical fertilizers of all kinds is less than 50 kilograms per hectare (45 pounds per acre) and there is not sufficient animal manure to make the soil yield as much as it should.

Population Contributes to Uneconomic Reclamation

Such pressure of population with the resulting scarcity of good agricultural land and sufficient food for the people has caused countries such as Italy to make very heavy investments to reclaim land, much of which was abandoned for cultivation many centuries ago and resembles a desert today. The clay hills of Italy comprise 50 percent of all hilly land and 20 percent of the total area of the country. These soils are impermeable to water and air due to the high content of clay. Their reac-

A. T. Semple is a member of the staff of the Agriculture Division, Food and Agriculture Organization of the United Nations, Washington, D. C. He took part in a Soil Conservation Meeting in Florence, Italy, September 13 to October 2, which was held at the "Accademia Dei Georgofili." The official delegates of the countries represented at this meeting were as follows: Prof. Van Den Abeele, Director General of Agriculture, Ministry of Colonies, Brussels, Belgium; Prof. Stanislav Najmr, Director, Institute of Agronomic Research, Prague, Czechoslovakia; Ing. Frantisek Hrosso, Head, Pedology Dept., Bratislava, Czechoslovakia; Mr. Ralph R. Waterer, Conservator of Forests, Nicosia, Cyprus; Prof. Stephano Henin, Directeur du Laboratoire du Sol, Versailles, France; Prof. Gino Passerini, Departmental Inspector of Agriculture, Florence, Tuscany, Italy; Ing. Augusto Alfani and Glenn E. Riddell, Ministry of Agrictulure, Rome, Italy; Prof. C. H. Edelman Director of Soil Survey, Wageningen, Netherlands; and Dr. Agr. Aasuly Loddesbl, Director, Norwegian Peat Society, Oslo, Norway. While they supplied most of the information which Mr. Semple has summarized for this paper, he assumes responsibility for all of the text.

Figure 1. In the reclamation of the clay hills, sodded channels are used to carry runoff down the valleys from one dam to another and across each silt-filled basin. Courtesy of the Consorzio Bacini, Montani, Brisighella, Faenza.

tion varies from neutral to strongly alkaline. During rainy seasons, gulleys and slides are very easily started. In dry seasons, they dry out and crack. Reforestation is difficult and also uneconomical because it requires treatment as intensive as for crop production without the same advantage and with greater probability of continued soil losses and eventual loss of the trees.

The most interesting and the first elaborate system of reclaiming the clay hills is known as "unita spina." It was originated at Meleto near Florence by A. Testaferrata and C. Riddolfi during the latter part of the 18th century. Until some years ago, it was adapted exclusively to clay hills, but now there is a tendency to spread this system to steep calcareous soils and those derived from sandstones.

The reclamation of the clay hills expressed as simply as possible consists of lowering the crests of the ridges and lifting the valleys. (Figure 1.) The raising of cattle and other livestock is considered indispensable for draft, improving soil structure, and increasing income and, therefore, is an essential part. Dwellings, roads, and water supplies are also indispensable in order to use the clay hills and keep the farmers living there. It is not uncommon for the costs of such work to exceed $1,000.00 per acre. Such costs should be considered in relation to the benefits not only on the spot but also to the land downstream and to idle people who are given employment. In Tuscany, the yields expected on such land are as follows:

Wheat—12 to 18 quintals per hectare (18 to 27 bushels per acre)

Corn—9 to 16 quintals per hectare (14 to 25 bushels per acre)

Alfalfa—30 to 50 quintals per hectare (2.4 to 4 short tons per acre)

Focusing Attention on Proper Land Use

Various happenings, such as the recent wars and the campaigns to relieve starvation and lesser degrees of malnutrition resulting from their destruction and dislocations, have focused attention on Europe's basic food supply problems. Obviously, the efforts to make each country self-sufficient by raising various kinds of frontier barriers following World War I failed. The extent to which soil resources have been destroyed or misused and the possibilities of correcting these conditions were brought out in the meeting of specialists in soil conservation at Florence, Italy, in 1948.

In the field trips, which were an important part of this meeting, it was observed that many centuries of agriculture have almost completely changed the original vegetation, the greatest changes being the reduction of forested areas and the partial denudation of the remaining forest by overcutting and overgrazing. Of the total productive areas of the country, 40 percent is divided into small and very small farms which produce food chiefly for the occupants. Forty-eight percent of the population is rural. Only 39 percent of the farm families work their own farms, 26 percent are tenants and sharecroppers and 27 percent are laborers and eight percent are in other categories. In all, there are 4,190,000 farms. Only 53 percent out of the total productive area is actually under cultivation while the remaining area consists chiefly of forests, hay fields and pastures, parts of which may be cultivated occasionally. A large part of the cultivated land is situated on the hills and suffers badly from erosion. Losses of good soil from the Appenine Arno watershed alone are equivalent to the total current manure production of the livestock in that area. And the Arno watershed is one of the best controlled.

Figure 2. Norway—A layer of peat about one foot thick being removed for fuel, exposing the bare rock and making the land useless for agriculture. Such a layer of peat on rock is too shallow for cultivated crops but has considerable value for forage and wood production.

Figure 3. *Left.* Without terracing, and with clean cultivation, erosion has ruined this vineyard on a hillside in the Maritime Alps. Courtesy of Ministry of Agriculture, France. *Right.* In this pasture region of southern France with a chalky soil and a rather dry climate, nearly all of the topsoil has been washed away. A small pedestal of the original topsoil with a vegetative cover which protected it from denudation by over-grazing remains in the foreground. Courtesy of Ministry of Agriculture, France.

In bringing about changes in land use, international collaboration can be helpful through providing imports of fuel and timber and through absorbing the emigration of people from non-arable zones where reforestation is necessary. In this manner, the continent-wide production of crops, livestock, and timber products can be increased to provide a higher standard of living for the people. The experience of some countries such as Switzerland show that protective land treatment and use according to its capabilities for forest, grazing, arable crops and other uses, not only stabilizes the productivity of the land but also helps to increase it.

Controlling Movement of Water for Plant Growth

In the Po Valley certain forms of terracing and ditching land to control the movement of water are estimated to be nearly three thousand years old. All the forms, both in the plains and in the hills and mountains, have the same objectives even if they may seem very different: 1. reduction of the slope gradient; 2. establishment of adequate run-off disposal systems (open and closed ditches); 3. sub-division of the area in plots by means of roads, etc. When the gradient is under five percent, the land is divided into small rectangular fields with various designs of ditches. On slopes above 30 percent, bench terraces are commonly used. In sandy soils the rises of bench terraces are supported by vegetation. On slopes above 45 percent, the costs in relation to land made available for cultivation are usually prohibitive.

In this Valley, where extensive drainage, even in the periods of normal rainfall (700-800 mm. yearly or 27 to 31 inches), has been necessary on account of the very low elevations, the following average yields per hectare are obtained; wheat 40 quintals; maize 60 quintals; hay 120 quintals; (wheat 60 bushels, maize 96 bushels, and hay 5.3 tons per acre). These yields are about twice as high as in ancient times.

For the removal of surface water by ditches, there are three principal types of treatment in which the rectangular fields are ridged. In one type known as *strena,* the wide and flattened ridges slope toward ditches on the long sides of the fields. Near one or both of the long sides of these fields, there is a row of vines and/or trees. The fields vary from 30 to 40 meters (100 to 130 feet) in width and 60 to 80 meters (200 to 260 feet) in length.

In the *piantata* type, the wide and flattened ridges slope toward the short sides or ends of the fields. At these points there are ditches and grassed farm roads or grassed roads alone which serve to carry off water from the fields. The individual fields on the long sides are separated by rows of vines and trees.

In the *cavalletto* type, the flattened ridges slope toward both the sides and the ends of the fields which are completely surrounded by ditches. A vine and/or tree row is located on a separate strip of land three or four meters (10 to 13 feet) wide between the ditches on the long sides of adjacent fields.

These ridges and ditches are very carefully and exactly laid out, with slope of the ridges and the capacity and gradient of the ditches adjusted to the permeability of the soil. Most of the work of moving the dirt has been done with wheelbarrows. Tile drainage has been used very little on account of the tight nature of the soils and the great intensity of the rains. The capacity of the ditches on the more open soils is 100-150 cubic meters per hectare (53 to 80 cubic yards per acre) and reaches

a maximum of 600 cubic meters per hectare (318 cubic yards per acre) on the heavy soils with the least gradient where natural drainage is most difficult and may stop entirely during and following intense storms.

While the development of irrigation and the extension of irrigated land have been going on in the Po Valley for many centuries, there are still important possibilities for greatly increasing production in this field. In Italy, it has been estimated that 370,000 additional hectares (914,300 acres) could be irrigated and the irrigation of 177,000 hectares (437,380 acres) could be improved. Similar opportunities exist in other Mediteranean countries, such as Greece and Turkey.

On cultivated land in Norway soil deterioration occurs principally by natural shrinkage in draining swamp land, removal with potatoes, root crops and weeds, water erosion, landslides and losses from the surface soil by percolation. On cultivated bog soil, the average rate of subsiding is about two centimeters (0.8 inch) annually. When it becomes too shallow for crops, it may be used for meadow or pasture. Since the annual rainfall in Western Norway is quite heavy, being about 3,000 millimeters (120 inches) and the soil lies exposed during much of the winter, being neither frozen nor snow-covered, it is subjected to the loss of fine-grained soil, mainly the colloid components, and also of plant nutrients due to percolation through the top soil.

On a cultivated bog, Braadlie found that drain water carried away 37 kilograms of K_2O (potash), 175 kilograms of CaO (lime), and 13 kilograms of nitrogen per hectare (41 pounds of K_2O, 197 pounds of lime and 15 pounds of nitrogen per acre). Correspondingly, six rivers flowing into Trondheimfjord annualy discharge 14,000 tons of nitrogen into the sea. Such loss of plant nutrients is also shown by the necessity for heavier manuring in western Norway than in other parts of the country.

Near Trondheim, Norway, in May 1893, about 300 hectares (740 acres) slid into a valley and about 860 hectares (2,116 acres) were flooded and covered with clay. Twenty-six farms were totally destroyed, 112 people were killed and 100 other farms were damaged. Efforts have been made to prevent such landslides by providing better outlets for underground water and by building strong embankments where they threaten to occur. Since they cannot always be predicted or prevented, some land is lost and damaged in this way every year. The government subsidizes such work to the extent of as much as 50 percent of the cost. For the smaller projects primarily to protect agricultural land, the Agriculture Department grants about 250,000 kroner ($35,250.00) annually. For larger projects along water courses, the National Water Courses and Electricity Service has provided from 2,500,000 to 3,000,000 kroner ($352,500 to $423,000) during the last two to three years.

In France, in certain regions with low fertility and intense rainfall, present cultural practices are inadequate to hold the soil, principaly on account of the cost of protective measures and particularly the amount of hand labor required. That is especially true in the case of vineyards and orchards, and also in areas of fragmented holdings (Figure 3). Incidentally, while the use of chemical fertilizers in France has practically doubled since prewar years, it is still averaging only 75 kilograms per hectare (67 pounds per acre).

Many Tiny Fields Interfere with Efficient Land Use

In many European countries, centuries of dividing land among heirs and recombining it by marriage has resulted in a large part of the individual fields being less than an acre in area and sometimes so long and narrow that they are less than a rod wide. Consequently, a farmer with 40 acres may have 50 or more fields, some of which may be miles apart, the distance varying with the distance which some of his ancestors travelled in search of a wife. Such small fields in a great variety of crops, often with bench-like stone and grass terraces, afford formidable barriers to erosion. At the same time, they make the use of drainage type terraces, diversion ditches and contour cultivation with horse- or tractor-drawn equipment practically impossible. The movement to reallot the lands operated by individual farmers is making notable progress in countries such as Holland and Switzerland. Under the law in Holland it is now possible to consolidate land holdings when even one farmer in a district requests it. This does not affect the total area of land held by individuals, excepting in one special district where there is provision for eliminating extremely small and uneconomic units.

In Central and Southern Italy and Sicily, the long rainless summers make the improvement of plant cover and the control of erosion very difficult. These conditions are typical of the Mediterranean area from Portugal and Spain to the island of Cyprus and neighboring countries in the Near East. Similar winter rainfall conditions also occur in Western United States, Chile, South Africa and Southern Australia.

Cyprus is partly mountainous and has a winter rainfall varying from about 250 to 1,140 millimeters (10 to 45 inches). For many centuries, the land suitable for cultivated crops and much land not suitable for plowing has been badly used. With the low fertility and poor water-holding capacity of the soil, farmers are accustomed to produce a crop of grain only every other year or every third year, leaving the land fallow during the alternate years. Recent experimental work has shown

that forage legumes can be grown during the fallow years, thus greatly increasing yields.

To stimulate the adoption of such practices, a Soil Conservation Branch has been set up in the Department of Agriculture. In the case of works requiring a considerable investment the best results have been obtained where the owners pay half the cost and the Government the other half. Now, the Government is formulating a law to facilitate the consolidation of fragmented holdings and to regulate land use.

Using Silt to Build New Land on the Coast

The process of building up lowlands by siltation, which has been carried out in the past in many places, is still used near the mouth of the Lamone River in Italy. In a silt-accumulating basin of 1,900 hectares (4,700 acres), silt is deposited in a layer six centimeters deep annually and siltation will be finished in 20 years. Siltation is stopped when the land reaches an elevataion above sea level of 0.84 meters plus ten centimeters for each kilometer (2.75 feet plus 0.54 feet for each mile) from the sea shore. Near the sea, it is necessary to silt up to 1.10 meters (3.6 feet) above sea level, the maximum level of the tide. Such soil has good texture, high water-holding capacity, good permeability and is rich in plant nutrients. Consequently, the first crop is alfalfa which is left for three to five years, then wheat, sugar beets, wheat and leguminous forage crops are seeded in rotation.

In Norway, the lack of forests for fuel has caused considerable destruction of soil in connection with the harvesting of peat (Figure 2). As the peat rests often directly on rocks, its removal transforms the land into ponds or swamps unsuitable for any economic use. After the peat has been excavated, the grass and heather turf from drier ground is utilized for fuel. In this way the surface humus layer is removed and the underlying mineral soil is exposed to erosion. It is usually too shallow or too coarse-grained for agricultural use. On the other hand, the ground might be used as grazing or for forest, if the upper layer were allowed to remain.

A committee appointed by the Department of Agriculture to formulate a plan to put an end to this form of soil destruction made the following recommendations:

1. Advisors should be appointed to make inventories, plans and investigations concerning peat, and to give information during the peat harvesting season.
2. Subsidies should be provided by the State for the building of peat-transport-roads.
3. There should be an inspection service to insure that the production of peat does not impair the soil for agricultural use.
4. Adequate support should be provided for the building of electric plants to supply electricity for cooking, which amounts to 60 percent of the total consumption of fuel. In this connection, the use of electricity for heating will be more expensive than the population can normally afford. An electric plant based on wind energy has been planned also. Accordingly, regulations have been prepared specifying the thickness of the layer of peat that must be left when excavation has been completed, varying according to the nature of the subsoil and the future use to be made of the ground, and including provisions for the use of such land.

Practicable Results in Wood Production

As a part of the program for using all land in accordance with its capabilities, production of wood is recommended in the Norwegian coastal district of Vestlandet, Trondelag, and as far north as Vesteralen in Nordland. In a total area of about 1,050,000 hectares (2,600,000 acres) there are about 240,000 hectares (600,000 acres) fit for the production of wood and about 110,500 hectares (300,000 acres) fit for pastures. The area suitable for the production of wood planted with pine (*Pinus montana*) will, 40 years after the planting is finished, produce about 700,000 cubic meters (25 million cubic feet) annually. The average annual production in the coastal districts of Hordaland to Vesteralen in Nordland is about 0.75 cubic meters per hectare (10 cubic feet per acre). The area fit for pasture, when properly improved, will provide sufficient grazing land for 275,000 cattle. In Holland, about 202,340 hectares (one half million acres) exploited for peat production have been converted into very good farm land.

In Italy legislation and regulations for the use of non-arable land have attempted to reconcile the problems of pasture with those of forestry by allowing grazing where

Figure 4. Fully stocked forest of Pinus halepensis in Cyprus. Courtesy of Forest Department, Cyprus.

the forests are not damaged. There have been many infractions of these rules with the usual bad results. In some areas of the South, the forests are so poor that they no longer have any importance in the formation of humus and protection of the soil.

In coppice, short cutting cycles are used on account of the heavy requirement for fuel. They would be acceptable if existing regulations could be enforced and followed. There is considerable evidence that the efficiency of well-managed coppice in protecting watersheds is not always inferior to that of the high forests. However, most Italian coppices are very short and too open on account of too frequent cutting and grazing so that their watershed value is very poor.

For 70 years, the forests of Cyprus have been under the protection of forest laws which were at first unpopular but are now accepted as necessary. The forests have been excessively grazed by large numbers of free ranging goats (Figure 4). An essential part of the process of freeing areas from goat grazing is to persuade the villagers to apply the Goat Law whereby the villagers may exclude free ranging goats from their lands by a majority vote. The regulations based on this law cover such matters as establishing and changing village boundaries, the making of petitions, balloting, issuing, publishing and posting notices and orders, the keeping of limited numbers of goats tethered or otherwise properly controlled, the movement of goats for slaughter, the confiscation of goats not properly controlled, the trial of offenders, the imposition of fines and the revocation of goat reduction and control orders. The application of this Law by the villagers is becoming very popular as it relieves them of the burden of damage to their crops and trees caused by free ranging goats. Up to now, 40 percent of the village population has applied the Goat Law.

The families formerly dependent upon the forests for grazing have been treated generously and compensated for the loss of their profession and provided with alternative livelihood. This has been costly but has proved to be the cheapest form of forest reclamation. Areas denuded by excessive cutting, burning and grazing have been treated with contour earth works to trap rain water and so to stabilize the surface for reseeding with conifers. This costs about $60.00 per hectare ($24.00 per acre).

The pressure of the population on the wood fuel resources has been largely relieved by converting Cyprus partially from wood fuel to oil fuel. As a long term relief measure, plans are well advanced to provide an island-wide grid to supply cheap electricity.

In France reforestation began in the Alps as a result of a law promulgated in June 1860. By 1928, more than 150,000 hectares (370,660 acres) had been replanted and the watersheds in the same regions had been controlled. As a consequence of the results obtained in the Alps, reforestation has been undertaken in other mountain regions, particularly in the Pyrenees and the Cevennes.

Heath Burning in Norway Damages the Soil

Uncontrolled heath burning for the purpose of improving summer pastures is still going on, especially in Western Norway. Since such fires damage the soil by

Figure 5. This fertile clay land in the valley of the Rhine has been completely ruined for agriculture by removing the soil to a depth of about 10 feet for the manufacture of brick. Courtesy of Professor C. H. Edelman. Photo by R. Hey.

Figure 6. Windrowing and loading lucerne to make alfalfa hay, near Sundridge, Kent. When the poorer, lighter and steeper soils are kept in forest and the better soils have their fertility maintained at a high level with fertilizers and grass and legume leys, soil erosion is not a serious problem in the United Kingdom. Courtesy of H. D. Keilor.

reducing the thickness of the layer of humus and also start forest fires, a proposed soil conservation law provides that heath burning be done on frozen ground only, and only after permission has been obtained from the local agricultural council. It is also proposed that raking up heather for fuel shall be prohibited in cases where there is little depth of soil down to rock or stones. These regulations are in accord with heath improvement practices which are used quite extensively in Scotland to obtain better winter pastures for sheep.

Along the Atlantic Coast of France and at many other points on the coast of the North Sea, sand dunes have encroached on the hinterland. These dunes have been stabilized by sowings of plants, such as beach grasses, furze (Gorse) and broom, amongst which pine trees have subsequently been planted. The first legislation to recommend the use of this technique dates from 2 July 1801. At the present moment, 100,000 hectares of dunes have thus been stabilized. Following this improvement during the second half of the 19th century, the hinterland was improved and in all, 700,000 hectares of pines have been planted.

On the lighter soils of the United Kingdom, Denmark, Norway and other countries of northwestern Europe, wind erosion is a serious hazard. Occasionally a fenland farm finds it necessary to replant a crop destroyed by violent winds, which remove the topsoil and kill the young seedlings. By using sod crops of strong rooted grasses and vigorous legumes alternately with deep-rooted and hardy arable crops, such as beets, carrots, barley and rye, much light soil is kept in heavy production. Producing lucerne (alfalfa) and grasses for artificial drying fits well in farming such land as the Norfolk light sands, if they are carefully managed.

In the light or fen soils of the Methwold-Feltwell area, some 6,000 hectares (15,000 acres) have recently been reclaimed for crops such as potatoes, onions and celery. While they are very liable to be blown away, they can be held by alternating such clean tilled crops with perennial grasses and legumes. Oftentimes, shelter-belts of trees and bushes are also necessary. Light lands which cannot be controlled economically by such means should be forested or kept permanently in grass.

Cities Destroy Some of the Best Farm Land

In many parts of Europe, maintaining fertile lands is made more difficult by competition from urban and industrial development than by deterioration due to mis-

management or neglect on the part of farmers. In Holland, the deepening of channels for ocean going ships and the pumping of huge quantities of water for urban use have contributed greatly to the problems of the maintenance of water tables at the most favorable level and protection of the soil against the entrance of salty sea water.

The increased responsiblity and authority established in the Dutch Ministry of Agriculture since the war enables it to protect better the interests of individual farmers and agriculture in general against the competition of commercial interest and rapidly expanding urban developments such as housing projects, roads, airports, recreational and industrial areas. There is much activity also in reclaiming swamps, lakes and parts of the sea bottom breaking up or removing impermeable layers of subsoil, regulating gas wells that may bring in salty water, controlling wind erosion on sandy lands by raising the water table, preventing land from sinking by careful study of drainage projects and regulating the use of soil for brick making (Figure 5).

In Great Britain, with about 7,284,200 hectares (18 million acres) of arable land in all and only 943,720 hectares (2,331,000 acres) rated as first class, it is alarming to realize that about 405,000 hectares (1,000,000 acres) were lost to agriculture between the first and second world wars. Under present conditions and prospects, it is estimated that about 1,000,000 hectares (2,471,000 more acres) will be removed from agricultural use in England and Wales within the next 30 years.

The military services now have over 405,000 hectares (1,000,000 acres). Playing fields alone projected for 268 new schools by the Ministry of Education will require about 1,500 hectares (3,752 acres). About 18,615 hectares (46,031 acres) have been recently requisitioned for open cast mining. New roads being planned will require about 4,856 hectares (12,000 acres). Eight projected satellite towns will require about 16,600 hectares (41,254 acres). Unfortunately, the best agricultural lands are in the greatest demand for such projects, because they are mostly level and therefore economical to reach and to build upon (Figure 6). Drainage problems are simpler. Transportation facilities and other public services are less expensive to install and maintain. Consequently, there is a strong and urgent movement to have such urban projects located in so far as possible upon land not suitable for food production of which there is over four million hectares (10 million acres) or upon rough grazing land which has a relatively low value for food production. Of such land, there is over six and a half million hectares (16,000,000 acres).

Guides for Immediate Action

European Governments are faced with grave and difficult problems that may interfere with the development of an adequate soil conservation program, regardless of its urgent necessity and extreme importance. Therefore, it seemed useful to the representatives of the countries meeting in Florence to indicate work that might be done under prevailing conditions.

1. Assistance should be given to institutions, officials and private persons who already apply or advocate various phases of soil conservation, which should be more widely used.

2. Publicity should be given to results of research related to soil conservation through the press, radio, schools and agricultural extension.

3. Soil conservation and proper land use should be taught in all schools as a part of agriculture, economics, geography and related subjects.

4. Demonstrations of conservation practices should be developed on typical sites wherever they are needed in each country to attract the attention of farmers and the public.

5. National land policies should be reviewed and trends in land use examined so that suitable steps may be taken for repairing past damage and for increasing future productivity.

6. Administrators in the government should become familiar with the importance of locating urban development on land less adapted for agriculture and not upon the richest farm lands.

International Cooperation is Necessary

Great benefit could be derived from more international cooperation among soil conservation workers. In cases where two or more countries have similar problems and do not see fit to maintain individually complete technical staffs, they could very advantageously pool their resources, coordinate their programs of work and hire men to do specific jobs which are not feasible otherwise. In proceeding along these lines they could exchange technical information, especially in the form of films, pamphlets, photographs and develop greater uniformity and better understanding in the terminology of soil conservation and land use. The facilities of FAO could serve most efficiently in helping to organize such joint action and in extending information available from each country to others where it should be useful.

LITERATURE CITED

1. Alfani, A. "Soil and Water Conservation in Italy." The FAO European Bulletin. Feb.-March 1948. Villa Borghese, Rome, Italy.
2. Alfani, A., and Calkins, H. G. "Italy's Major Land Problem." Soil Conservation. Vol. XIV, No. 12. Vol. XV, No. 1. July-Aug. 1949.
3. Allen, J. S. "Planning Outlook." The Journal of the School of Town and Country Planning, King's College, University of Durham, Durham, England. Volume 1: No. 3. Autumn, 1949.
4. Draghetti, A. "Principi di Fisiologia dell'Azienda Agraria" 1948. Instituto Editoriale Agricole. Via Mantegassa, Bologna, Italia.
5. Ignatieff, V. "Efficient Use of Fertilizers." August 1949. Food and Agriculture Organization, Washington, D. C.

(*Continued on page* 93)

Splash Erosion in Pictures

W. D. ELLISON

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WHEN WE CROP THE FIELDS and graze the lands in ways that permit high-velocity raindrops to strike bare soils, the splash erosion process becomes active. The first product of this splash is mud, and in no case will a soil absorb mud as freely as it absorbs rainwater. Most soils are practically "waterproofed" by the intake of only very small amounts of this muddy surface water. *Often the same soils would take in hundreds of thousands of gallons of clear water per acre, and yield much of this intake to ground water, to stream flow, and to the seepage that goes into reservoirs.* This sealing and waterproofing of the land by the intake of muddy water is deeper than just the surface, and over a long period of years some lands undergo a hardening that may retard deep groundwater replenishments from even the gentlest of rains or from the melting snows.

The splash erosion process which covers the surface with mud also damages the soil's physical, chemical and biological properties, even though all of the splashed mud remain on the field. To control soil erosion we must prevent erosional damages caused by the splash of falling raindrops. Among these damages are *puddle* and *fertility* erosion. Puddle erosion is merely a condition of depleted soil fertility, caused by an erosive agent.

If we do not start our conservation programs with control of the raindrops, we can achieve little more than (Mud conservation ma be defined by the humorist as the science of letting a field become a muddy mess. It takes the raindrop's impact to do this messing up.) If a crop or mulch cover on the soil dissipates the raindrop's energy before it strikes the soil, then the rainwater remains clear and it is pulled in by the soil's capillaries as it falls; the soil retains its open, porous structure, and we find clear water and stable soil (unmixed) over entire fields.

There was a time when we were so busy trying to keep the mud on the slopes, that, as we sometimes put it, we had no time to chase after raindrops, not so long as the runoff continued making gullies one could hide a house in. But now we know this concept was a companion to the one which provided no time to eradicate the termites; not so long as one was pressed for enough time to cut timbers needed to repair the floor beams that were failing.

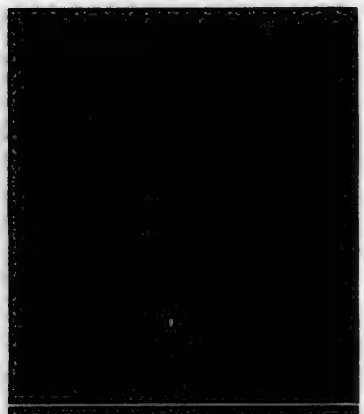
The splash erosion science now being developed will do much to advance soil cover practices. For the first time, it provides us a method for evaluating the covers under raindrop action in terms of their capacity to bring about soil stability — the stability that is needed to prevent puddle and fertility erosion damages.

I am often asked why the Navy is interested in problems of conservation and soil erosion. The answer may be found in several millions of acres of lands used in shore operations; in operations by marine and seabee units; and in a general need to employ principles of soil erosion control for the protection of roads, buildings, docks, and other installations. At the conclusion of the war, the land holdings were more extensive than seemed necessary for present-day operations. Consequently, the Navy has a program for turning some of these lands back to the civilian economy. Of the approximately ten million acres of lands within the continental limits of the United States, exclusive of Alaska, held by the Navy on VJ-Day, one-half has now been returned to civilian control.

The program of conservation carried out on these lands while under Navy control has thus been of direct benefit to the communities in which they are located. In areas where the Navy has retained control of land, we aer cooperating with local authorities in the development of a pattern of land protection and care. The whole program is based on the theory that mutual assistance in the technical aspects of conservation will be of benefit to the Navy and the civilian economy alike.

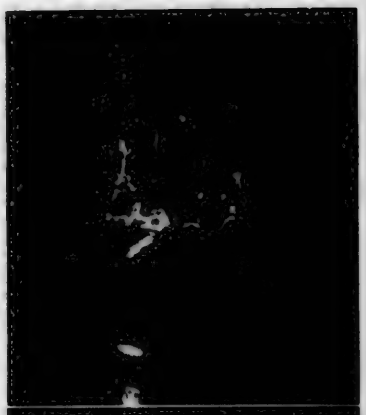
In reference to the accompanying photographs, this work was sponsored by the Bureau of Yards and Docks, and the photographic work was by the Naval Research Laboratory, at Washington, D. C. They are divided into four series A, B, C, and D. They tell their own story, and nothing more than a little field experience will be needed as background to put their story to some practical use. Undoubtedly, the conditions photographed in Series A would cause most sheet erosion damages, and they would also cause most fertility erosion. But we would expect greatest puddle erosion damages to result from splash in one of the other series.

Splash Erosion by a Falling Raindrop

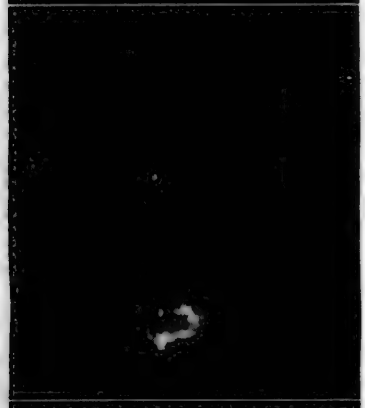


SERIES A: The water is approximately one quarter inch deep over the soil. Exposure—approximately two milli-seconds.

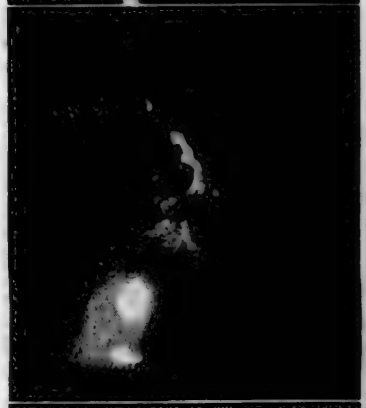
A drop of water 5.5 mm in diameter, after falling approximately seven feet is in contact with the surface water.
←



The surface tension now draws the top of the film wall inward. It appears as though there was a rubber band in the upper edge of the film. The whiter appearance of the wall indicates it is becoming thicker. →

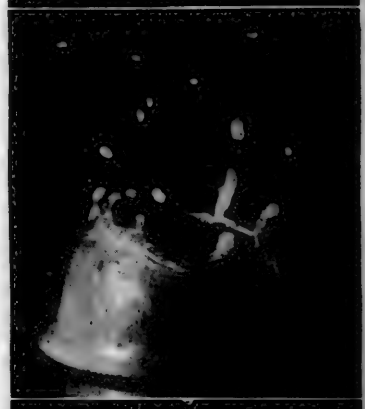


Water is being "kicked" back as drop embedds. It appears that the embedding process causes the drop to spread just beneath the film of surface water, and that this imparts upward velocity to the spreading film of water.
←



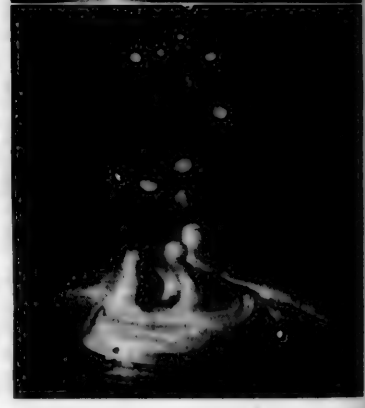
The top is closed and sealed, and the "bag" is filled with entrapped air. Now the film must break before it can recede.
→

The film continues to move outward and upward. A few particles fly off from the upper edge of the film wall.
←



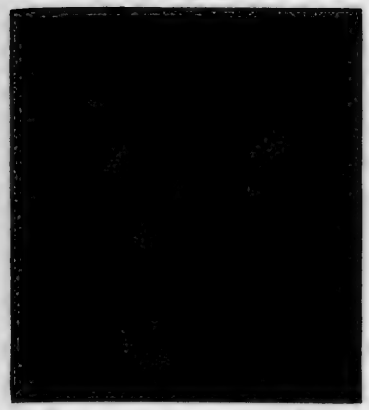
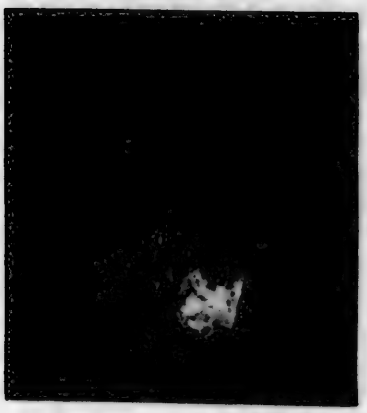
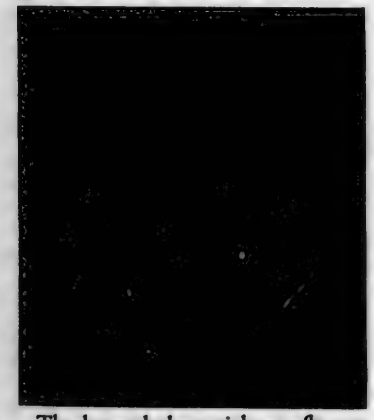
The film breaks and begins to recede.
→

The film wall continues to move outward and upward. Note the wall is becoming more vertical.
←



As recession continues it further agitates the surface water. This agitation was begun at the instant of imprat. Much of the film that rises into the air returns to the surface. Very little flies off. →

Photographs by Naval Research Laboratory, Washington, D. C. V. P. Robey, Photographer.

Series B	Series C	Series D
		
The water is approximately one sixteenth inch deep. Same drop size and same fall distance as in SERIES A. Early stages of splash omitted. Note that film wall is almost vertical.	*Less water than in SERIES B. Same drop size and same fall as in SERIES A.* Note that the film is irregular because of lack of surface water.	*The soil is wet, but the film of surface water is not continuous. Same drop size and same fall distance as in SERIES A.* The very irregular wall that rises is heavily charged with soil.
This film is much thinner than film in Series A and instead of receding, most of it breaks up and splatters. Here splash erosion may transport considerable amounts of soil via splash process.	This film wall never becomes vertical, but spreads onward at top in punchbowl shape — probably because of irregularities in film which does not provide tension to restrain them.	The action spreads, but there is not enough water to form a film wall of any appreciable height.
		
The last splash particles to fly out are heavily charged with mud. This shows the beginning of puddling — a process that is almost a land disease where cover protection for the soil is not designed to match a soil's protective requirements.	Most of the film that rises, breaks into small particles and here the splash erosion process, even though acting alone on a sloping hillside, will detach and transport large amounts of soil on bare fields.	The cavity is symbolic of three forms of damage. (1) Splashed soil will be transported down slope. (2) Clay soils will be puddled. (3) Sandy soils suffer fertility erosion and leave heavy sand grains.

Controlling Water on the Land

E. N. MUNNS and LEON LASSEN

Water Conservation is a problem of major concern and involves a number of factors that are often overlooked or are not too well understood. Munns and Lassen discuss a number of the more important soil-water relations and how they affect runoff. They also point out some of the ways of increasing the storage capacity of the soil mantle such as the effective depth of the soil affected by roots, increasing the incorporated organic matter content of the soil material and by actually increasing the soil depth.

THE CONTROL OF WATER is a major problem in conservation. Uncontrolled water forms our floods. Uncontrolled water is responsible for much soil erosion. It is the first symptom of land abuse.

Control of water begins on the land. To achieve it good land use is needed. Many measures are necessary such as the reinforcement of vegetation, strip cropping, terraces, contour trenches, and gully plugs. Each of these practices helps control water because each affects the water relations of the soil. In the end, it is the soil that is the common denominator in obtaining water control on the land.

True water control involves the entire soil mass. This is the volume of earth material which is occupied by the roots. It is in this zone that changes in water behavior can be induced. Prominent among the factors involved are those of infiltration and storage. Both of these can be materially influenced by the manner we handle the vegetation and by various conservation measures.

Infiltration is Governed by Soil Structure

Infiltration is governed by the void space in the soil and by the structure of the soil mantle. Obviously, the objective of the conservationist is to maintain as high a proportion of void space and as loose a soil structure as possible. Numerous studies indicate however that wherever surface runoff is high and infiltration low, compaction is presented in at least a portion of the soil mantle.

Compaction may be only veneer thin on the surface or may extend several inches into the mantle and may occur on soils with or without a vegetative cover. A common cause of compaction is falling raindrops striking exposed soil, creating muddy water which partly clogs the surface pores. The best defense against this is vegetation, living or dead, on the soil. The problem with many agricultural crops is to provide such a cover and yet keep the land in cultivation. In arid and semi-arid areas, the major problem is to get vegetation started, and once started to maintain it. One part of the answer has been suggested by the findings of Fletcher and Martin (1), that a microfloral invasion of the crust, formed on exposed soil, improves infiltration, decreases erosion and aids in the establishment of plant seedlings even under desert conditions. As yet we have still to find out what man must do to favor the microfloral invasion.

Compaction due to man's direct activities is as great, if not even greater than that caused by rainfall. Over widespread areas it is caused by the trampling of livestock and by the use of heavy farm equipment. On limited areas it is found in roadways and trails, in places where logs have been dragged, or where an intense fire has occurred. The engineer is well aware that compaction assures drainage of road embankments. He uses mechanical means to increase the density and decrease the size of large pores; one type of tamper, appropriately enough, is even called a "sheepfoot roller." The effect produced by this tamper is the same as that of farm equipment or trampling by grazing animals.

Studies by Alderfer and Robinson (2) in Pennsylvania have shown that heavy grazing severely compacts the upper inch of surface soil. In tests on ten sites they found that volume weights of the 0 to 1" soil layer ranged from 1.54 to 1.91 on the heavily grazed sites and from 1.09 to 1.51 on ungrazed and lightly grazed sites.

It is the condition of the upper soil layer which determines the runoff rate from a soil mantle. Rates of runoff will increase rapidly if this layer becomes compacted: in these tests runoff ranged from 33 to 80% on the grazed sites and from 0 to 10% of rainfall on the ungrazed sites. The regulation of grazing is the obvious answer to this problem.

Compaction can even destroy the value of forest vegetation as a promoter of good infiltration. The common belief that forest soils possess high infiltration capacity, is not supported by the low capacity of pastured woodland, invariably far lower than that of adjacent ungrazed woodland and often less than that of unused open land.

For example, a grazed woodland at the Coweeta Ex-

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This paper was presented at the annual meeting of the Soil Conservation Society of America held at St. Louis, Missouri, November 10-12, 1949.

perimental Forest in western North Carolina produced more surface runoff than adjacent bare cropland. Compaction by livestock had reduced the permeability of the surface soil in the woodland to ten percent of that which was found before grazing. In the first four inches of depth, water storage was reduced from 1.2" to 0.5". It is evident that the forest is most effective in promoting infiltration when its surface soil is unimpaired.

Logging Compacts the Soil

Commonly used methods of logging compact the soil. In western North Carolina peak flows of a watershed so logged increased 65 percent over those which were noted previous to cutting. Stream rises after cutting were characterized by sharper breaks, peaks and recessions. In other words, the hydrographs of flow assumed those characteristics usually associated with hydrographs of surface flow.

Recent investigations have indicated that an impermeable type of frost forms in compacted soils. Frost forms in uncompacted soils but it is usually of a type permeable to water. Dense freezing in compacted soils, studies reveal, may be directly responsible for excessive snow melt flood flows in northern streams. Further studies are needed on this phase; in northern areas the importance of these studies cannot be over-emphasized.

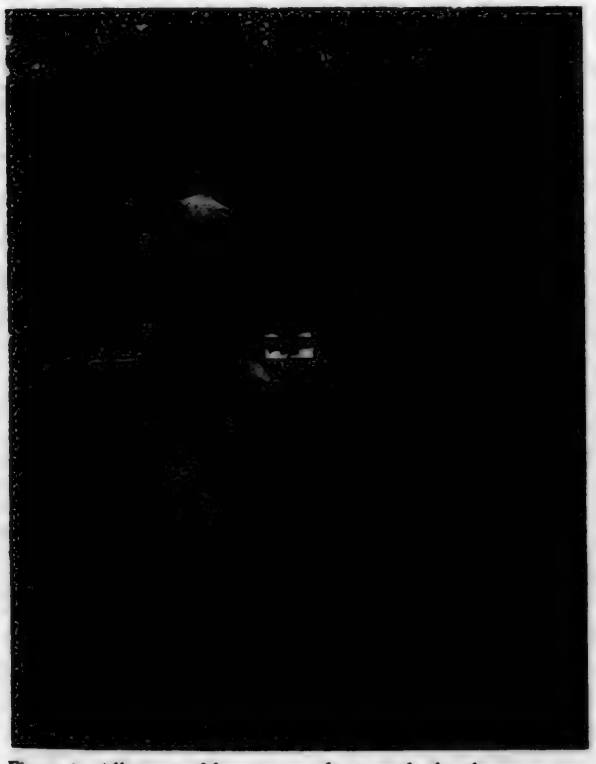

Figure 1. All types of logging result in marked soil compaction especially when carried out on wet soils.

Very often the vicious characteristics of compaction may linger long after the cause has been removed. A foot or deer trail may be discernible for years after travel over it has ceased. Wagon tracks of the pioneers can still be seen in parts of the West. Logging roads used in harvesting old growth timber can still be traced in the succeeding forest which is approaching the cutting age. In some areas roads are the source of heavy rates of runoff and hence the importance attached to them here. In some parts of the West the exclusion of grazing from test areas for as long as 30 years has failed to remove the effect of compaction caused by heavy grazing. Studies of tractor compaction on cropland have disclosed the persistence of subsoil compaction and indeed its continued development ever under light weight tractors. Where such conditions are found it is an indication that nature must be helped in the restoration job. While much is yet to be learned we do know that in a great many instances the mechanical breaking up of the soil, seeding with plants of the proper rooting systems (shallow rooted plants for shallow compaction and deeper rooted plants for deeper compaction) and fertilization to induce profuse plant development can help nature obtain quicker results.

Water Storage in Soil Mantle Important

Along with increased infiltration capacity the conservationist must consider the surface detention and the water holding capacity characteristics of the soil mantle as they enter into runoff reductions. A high surface detention capacity is desirable and may be achieved by such devices as furrows and detention basins. Under some conditions an increase in surface detention may be obtained by natural means. For instance, in the forest the accumulation of litter and the increase in soil depth due to the development of humus tend to increase the effectiveness of various sized depressions and irregularities common to most sloping land. There is no argument about the effectiveness of surface detention, the job of the conservationist is to find means of promoting maximum development of this phase of water control.

Of greater importance however in the control of water is storage in the soil mantle. Some exceedingly shallow soils of a gravelly nature have some of the highest known infiltration capacities. These same types of soil are also known to have practically no retention storage value for flood control. On the other hand, there are shallow soils of heavier texture with a retention storage capacity sufficient to withhold a large amount of water from peak flows. Some sands four feet deep can retain only two inches of water while some clays of the same depth can hold 12 inches. It is obvious therefore that the mag-

nitude of some flood flows is determined principally by the lack of available retention storage. Can the storage capacity of a soil mantle be increased by man? We think the answer is yes, and this is where plants, both alive and dead, play another important role in controlling water.

Methods of Increasing Storage Capacity

There are several ways of increasing the storage capacity of the soil mantle. One is by increasing the effective depth of soil affected by roots; another by increasing the incorporated organic matter content of the soil material; and still another by actually increasing the soil depth. While storage capacity can be increased at the same time in all three ways, we will discuss each separately.

First of all, live plants remove water from the soil, thus making available its inherent storage capacity for additional precipitation. This removal is simultaneous throughout the entire depth of the rooting system, a natural phenomenon which makes the plant fully effective in creating retention storage space for rainfall. This is a commonwealth statement but it is one which is of tremendous importance if its implications are understood. It indicates that we can increase the water holding capacity of a soil mantle by using deep rooted species. Thus with a soil possessing two inches of storage per foot of depth, we can increase its capacity to two, four or six inches depending on whether the rooting system of the vegetation penetrates to a depth of one, two or three feet. This is one of the most important ways of increasing the effective capacity of a deep soil mantle. What seems peculiar to us however is that while this fact is generally known the conservationist has made but little use of it in runoff control. Further study of this factor is urgent.

Another method of increasing storage capacity is to incorporate organic material in the soil. We have previously shown that sandy soils have the least retentive storage capacity. Fortunately organic matter acts to create the greatest increase in storage capacity in sandy soils and the least in clay soils. In forest areas the incorporation of organic matter is performed by soil fauna and the conservationist is always trying to develop conditions favoring the increase of fauna activity. We still have however to learn how to create conditions favorable to the development of soil fauna in the arid and semi-arid regions.

A corollary method of increasing storage capacity applies particularly to shallow soils. Nature is always trying to increase their depth. Plants aid in the deepening of soils by breaking down impermeable sublayers, and cracking and splitting rocks. This is a slow process, requiring centuries. Nature however has provided another and much more rapid way of deepening the soil. This is through the addition of organic material to the surface of the soil. In the dense hardwood forests of the Appalachian Mountains a wide variety of deciduous trees grow in mixture. It is not uncommon to find 20 or more different species on an acre. These trees an-

(*Continued on page* 93)

Figure 2. Surface detention achieved by detention basins on intensively used range land in the Southwest.

Drainage in Conservation Farming

T. W. EDMINSTER, J. P. WALKER and J. H. LILLARD

The authors of this paper feel that the urgency of action together with the impediment of technical complexity makes essential the design of new tools to aid the engineer in efficient and effective drainage design. They further point out that soil conservationists should encourage and support not only the application of drainage on agricultural lands, but also support the research necessary to speed up and develop a sound economical program of drainage in conservation farming.

THERE SHOULD BE little doubt among conservationists that agricultural drainage is one of the more important phases of conservation farming. Drainage provides a direct means of bringing about the proper use of land in accordance with its capability and of treating it in accordance with its needs. Since its beginning, agricultural drainage has been a means of increasing the productive capability of lands having inherent fertility and productive capacity but having improper environmental conditions for plant growth. This increased production on the flat wet lands has been a step towards good conservation farming because it has compensated for production which might otherwise have been made on sloping erodible areas. In today's conservation farming, drainage makes it possible to move erosion-producing cultivated crops to the more productive bottom lands and to return close-growing conservation crops to the uplands. In many areas, drainage and irrigation go hand in hand in maintaining proper soil conditions for efficient crop production.

The fact that conservationists have a tremendous drainage task ahead of them is evidenced in the estimates that improved drainage is needed on approximately 29 million acres of cultivated land. (1) An additional eight million acres of irrigated land need drainage to control water tables and to prevent alkali damage to soils. This total of 37 million acres is an immediate objective and challenge to conservationists. As a further objective, there still remains approximately 20 million acres of wet land not yet cleared for farming.

The accomplishment of such an extensive drainage program is dependent upon many factors. Costs, technical-design problems and economic factors all provide limitations.

Hand labor has jumped from $0.75 to $1.50 per day to $0.75 to $1.50 per hour, while tile that once sold for 3 cents per foot is now 9-12 cents per foot. Hand labor has been almost entirely replaced by machines—traction ditchers, drag lines, pull-back grader blades on heavy tractors, etc. But, even machine costs are high and there is still no way to substitute for the present high costs of materials. Such rising costs on both labor and materials make careful planning and project evaluation, together with efficient design, most essential.

Conservationists and engineers dealing with our nation's drainage problems must carefully determine the economic feasibility of drainage proposals. Installation costs must be carefully balanced against the expected increases in reveune from the drained areas. Soil fertility, market outlets for crops, labor, seasonal factors, etc. must all be checked. It must be assured that the benefits derived from land drainage will exceed the cost of the drainage work. In cases where drainage-district taxation exists, these benefits must be sufficient to cover not only the assessments but also sufficient to cover the costs of the drainage improvements that must be made on the individual farms. Amortization of the drainage debts must be sufficiently repaid to assure complete solvency before maintenance and repair costs develop as the system ages.

Since the economic feasibility of drainage is in a large part dependent upon intensity of the farming operations for the land to be drained, much will depend upon the crops and cropping system to be involved. For example, with high per acre value crops such as potatoes, the probability of the returns exceeding the cost would be much greater than in the case where the crop rotation involved corn, wheat and hay as pasture.

The problem of evaluating such economic factors are being solved to a large extent through the extensive use of land capability surveys. Through this medium the engineer can obtain more definite information as to the potential productive capacity of the soil to be drained.

This paper—a joint contribution of Soil Conservation Service-Research, U. S. Department of Agriculture, and the Agricultural Engineering Department, Virginia Agricultural Experiment Station, Blacksburg, Virginia—was presented at the annual meeting of the SCSA held at St. Louis, Missouri, November 10-12, 1949.

T. W. Edminster is Project Supervisor, Soil Conservation Service—Research Division, J. P. Walker is Drainage Engineer, Soil Conservation Service—Research Division and J. H. Lillard is Project Leader, Virginia Agricultural Experiment Station. Their headquarters are at Blacksburg, Virginia.

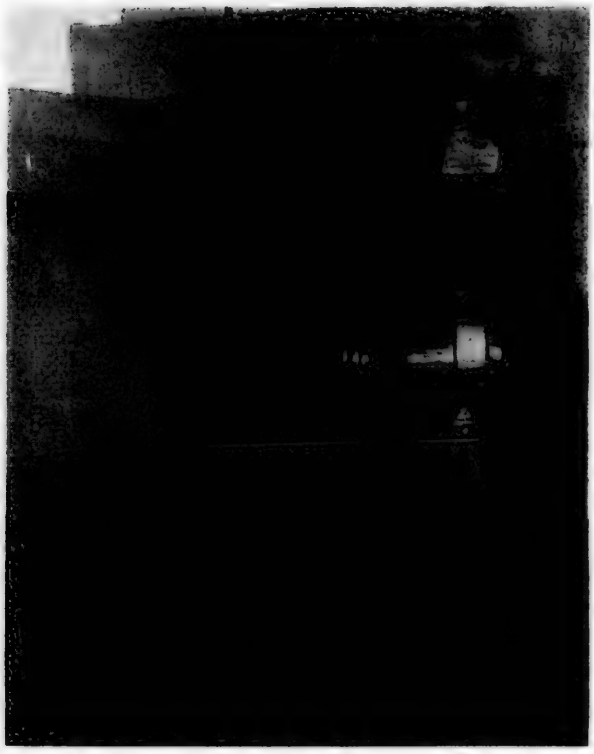

Figure 1. Close-up of "draw-down" pump, meter and sump well equipment.

Agricultural economists are giving further aid through the evaluation of the marketing and labor factors.

However, as conservationists, we have a problem to answer—what and how extensive are the economic benefits that can be assessed against the conservation value of farm drainage? Can we, on the basis of the conservation value to be received, afford to go into drainage operations on an extremely narrow margin of monetary benefits? If so, how narrow can this margin be? What factors should be considered in evaluating these conservation benefits. Can and should we, as conservationists, develop specific standards for such evaluation?

The importance of efficiency in design as a major criterion in modern drainage programs is evident. However, achievement of such efficiency constitutes one of our most difficult problems.

It is recognized that engineers who deal with drainage design over a period of years become adept at evaluating the effects of soil, topography and plant requirements in drainage system design. Unfortunately, this ability to evaluate properly these many factors cannot be readily and quickly transferred to the many engineers who are being called upon to extend the accelerated drainage program.

The "rule of thumb" methods used by experienced drainage men in design work must be replaced by quick, accurate and measurable criteria. This is not a new realization by any means. Such workers as Messers. L. A. Jones, J. R. Haswell, F. E. Staebner, D. L. Yarnell, S. M. Woodward, J. R. Neal, C. E. Seitz, F. O. Bartel and others have conducted many excellent exploratory studies in search of some sound procedure that would replace, in some measure, the factor of experience in drainage system design.

Renewed research effort is being placed on this problem in many areas of the country. The search for measurable criteria for drainage design is following a general pattern in nearly all of the studies and is based on the premise that drainage design may be related to measurable soil-moisture movement characteristics.

For an example of the type of research program that is underway, let us make a quick review of the work in progress in Virginia. This study, conducted jointly by the Research Division of the Soil Conservation Service and the Virginia Agricultural Experiment Station, has been underway since 1946.

Basic in this project is the study of water-table movement characteristics under various drainage patterns and under various soil types. Representative areas of soils that present drainage problems have been carefully selected. In some cases these have been areas upon which drainage systems already exist, in other instances, they are areas that are scheduled for future drainage. Various types and designs of observation wells have been placed across the existing drainage lines. The ground-water level in these observation wells is determined either by a continuous recording instrument or manually by inserting a manometer tube to the water surface. These water levels are plotted on a carefully prepared diagram of the soil profile as it exists across the line of wells. A picture of the water-table "draw-down" is thus produced.

On the undrained areas, a "controlled" condition of drainage is created by using a central collecting well in which the water level is maintained at a predetermined depth below the ground surface by a pump operated with a float switch. Observation wells reach out from this simulated drain. Here, in addition to manually read wells, a series of recording wells are used. Through use of these rceorders, it has been possible to determine variations in rate of water table change as it might be affected by precipitation, temperature, barometric pressure, soil profile differences, etc. Under both setups, the observation wells make it possible to prepare "draw-down" curves showing the distance out into the soil that the drain affects the water table. As soil type and management practices change so, also, do the shapes and conformations of these "draw-down" curves change.

While these studies of water movement characteristics are being made on a field basis, intensive soil permeability determinations are being made on a core sample basis.

The methods as roughly outlined above have produced many new concepts and considerations. For the first time, it is becoming possible to study the correlations that may or may not exist between such elements as soil texture and structure, temperature, soil moisture viscosity, cover changes, tillage practices, various meteorological factors and the actual time and rate of water table movement. Many surprising factors are coming out—too numerous and too complex to consider here.

These techniques are producing tangible results—not only in Virginia but also in the states of North and South Carolina, Georgia, Ohio, Michigan, Illinois, Iowa, California and others. There are some variations in the methodology—but, the basic pattern is similar.

The question that conservationists should be asking is —"Are we utilizing every possible and effective means of quickly pinning down the factors necessary in providing the 'measurable criteria of efficient drainage design'?" Are there other techniques that would be more effective? Can improved methods be borrowed from workers in other fields? Should wider use be made of electric analogue, dyes or radioactive trace procedures.

Reference was made to intensive core sampling in the experimental areas for the purpose of making permeability determinations. This work constitutes a second important phase of the research program.

During the past several years, the Soil Conservation Surveys Division of the Soil Conservation Service has been developing an extensive program to determine the relative permeability of the soil profiles all over the country. The program follows relatively standardized procedures; i.e. the rate of transmission of water through core samples is coupled with pore space and volume weight determinations. (2) As these cores are taken, carefully selected and specially trained soil scientists prepare detailed profile descriptions, noting in particular those structural factors and other clues that affect water movement. Although greatest emphasis has been given to soils with drainage problems, upland soils are also under study. Conservation survey personnel have found results of these permeability surveys valuable in determining sound breakdowns in mapping units for use in farm planning. To the soil scientist, these permeability determinations have provided a new "tool" for improving their understanding of differences in soil units.

The question that has naturally developed in the minds of research engineers is: If this permeability can serve as a tool for soil classification, can it, through the medium of correlation, be made to reflect the results of "draw-down" curve studies and other known drainage design criteria? Is it possible for the research worker to correlate permeability data and its specialized profile descriptions with the results of observation-well studies, pump "drawn-down" studies, and other studies to a point where these results can be determined or predicted by the soil scientist?

As our soils men become more experienced and expert in detecting the factors which affect water movement, they have shown increased ability to predict with reasonable accuracy the permeability class a sample will fall into. Is it not reasonable to believe, as more experience is gained over a wider selection of soil types and conditions, that the soil surveyor may ultimately be able to assign permeability values to soils on the basis of observed soil characteristics rather than from the results of the more detailed laboratory determinations?

If this "dream" is permissible, then is it not possible that an "index of drainage design" might some day be placed on the land capability map just as the land capability classes are now assigned?

These are extreme and radical conjectures—they presuppose relationships and correlations between many factors; relations that, in theory, would seem closely allied and easily correlated but Research has yet to establish and prove beyond question or doubt the existence of these correlations.

Yes, these are extreme hopes—but they are true *objectives.* They are objectives to be explored and pursued by all who hold to the importance of conservation. The job of drainage for conservation is a big tough one —it is complex, socially and economically—it is com-

(Continued on page 93)

Figure 2. General view of "drawn-down" pump installation with pump house and sump well in center and water table observation wells radiating out from the well.

BOOK REVIEWS

AMERICA'S SHEEP TRAILS. *By* Edward Norris Wentworth. *Iowa State College Press, Ames, Iowa. 667 pp., illus. 1948, $7.00.*

In a monumental history of the sheep industry of the United States, Edward N. Wentworth of Armour's Livestock Bureau makes available a wealth of detail which served as background to the fascinating book, *Shepherd's Empire*, published three years earlier with Charles W. Towne as co-author.

Conservationists concerned with the western range country will profit from a careful study of this book. It will yield a better understanding of the historical background of modern grazing problems.

On two points, in particular, it will serve to correct common bias in range thinking: (1) the predominance of cattle traditions in the West, and (2) the idea that over-grazing is a relatively recent occurrence and that the memories of living "old-timers" can be relied upon for true pictures of the virgin range.

America's sheep trails have reached to literally every corner of the continent—often, in contrast to popular notion, well in advance of cattle. "No hunter, explorer, or scientist has penetrated the obscure parts of our western mountains and forests with the frequency, thoroughness, or methodical regularity that has characterized the sheepherder," Wentworth points out in his preface.

An era of great trail drives of sheep paralleled the cattle drives from 1865 to 1901. Of these, the author comments: "A half-century of tradition comes from the Texas cattle trails, with their cowboys and longhorns. The great sheep drives from California and Oregon, however, have been veiled in obscurity. The heyday of the latter stretched over three decades, and the rush of their hoofs fully equaled that of the more widely publicized cattle."

But possibly of more significance to the range conservationist are the sheep drives of two centuries earlier, which fanned out from Mexico over the southwest and along the Pacific coast. The impress of these flocks upon the vegetation and soils of vast areas doubtless persists to this day, all but unrecognized by technicians whose perspective dates from the Anglo settlements of the West.

When the first sheep were landed on the eastern seaboard with the Jamestown colony in 1607, the semiarid southwest had known the feel of "the golden hoof" for nearly a century, beginning with the expedition of Cabeza de Vaca in 1528. The era of Spanish missions, colonies, and ranches later established on large grants of land, was based largely upon sheep grazing.

Wentworth cites many records of flocks in the southwest in the seventeenth and eighteenth centuries. For example, "At the San Francisco mission near San Antonio (Texas, in the late 1700's) there were four thousand sheep and goats, and the four missions of the vicinity totalled over twelve thousand head." And, at the beginning of the nineteenth century in New Mexico, "Possession of a quarter to a half million head was not uncommon," and the Spanish governor, Baca, "kept nearly two million head of sheep and had twenty-seven hundred peons always on the range with them."

"The close of the eighteenth century saw Spanish flocks in eastern Texas, in the San Antonio region, in the mountains above Sante Fe and Taos, and throughout the New Mexico valleys, as far north as the Gila in eastern Arizona, in the Moqui country, and up to San Francisco Bay on the Pacific."

When it is considered that the Spanish ranchers also kept cattle and horses, it is evident that use of the western range was considerable at an early date. Records of livestock losses during drouths of those times are proof that grazing effects must have been disastrous, at least locally.

The lasting influence of this early, and obviously unregulated, grazing on the range vegetation of the West is problematical. Its evaluation is a real challenge to ecologists, and when completed certainly will affect fundamental concepts of conservation. Is it possible that much of the so-called desert range of the Southwest is man-made? May this help explain the annual ranges of California where the supposed perennial climax grasses are practically non-existent? What unsuspected connection may it have with the brush problems of the Southwestern savannahs?

Profusely documented in the best historical style, and supported by an extensive bibliography, the book is a mine of information on many aspects of the sheep industry, from the beginnings mentioned above to the present decade. An easy factual narrative, and a moderate viewpoint on the many controversial topics discussed, sustain the reader's interest and win his confidence. Large type and an attractive two-column-to-the-page format make the book easy on the eyes. Numerous expressive sketches by H. D. Bugbee decorate the text and a generous selection of photographs augment the story.

This is truly a work worthy of the industry it commemorates.

—Ben Osborn, *San Angelo, Texas*

BOBWHITES ON THE RISE. *By* Verne E. Davison. *Charles Scribner's Sons, New York. 1949. 150 pp. $3.75.*

This book presents in simple and clear-cut style the needs of and management opportunities for the bobwhite in the United States. The theory and practice of quail management is presented in a manner that any hunting license buyer or landowner can easily read and understand.

Under an early chapter entitled "Traditions to Forget" the author cushions the reader for today's management opportunities by dispelling many old wives' tales and fallacious ideas that have hindered programs in better management for years. After getting the reader in a mental mood acceptable to sound logic, the field of bobwhite management is presented in dozens of know-how examples. The author draws fully upon his own work and experiences as well as those of the Soil Conservation Service, clubs, individuals, and some state game departments who have worked out and put into effect successful quail management practices the past 20 years.

The main thesis of this handbook is centered around two facts; namely, that soil conservation goes hand-in-hand with quail management, and that the greatest opportunity is the planting of bicolor lespedeza—the wonder plant for quail. The author is on a sound basis, and he tells the reader how, when, and where to do the job to get bobwhites on the rise. Not only does the text inform you how to get the birds on the rise, but just as important, how to keep them there once you get them there.

The landowner who is the least bit interested in bobwhites will gain many usable ideas by reading this book —not only on quail management, but also on the subject of better management of his farm. The quail hunter will profit as much as the landowner from this book because it will open up doors of opportunity to him to help get bobwhites on the rise.

The book is dedicated to those who hunt the bobwhite and to the landowners who alone can grow more of them. To both groups the reviewer advises that they obtain the book at the earliest possible date.

—Logan J. Bennett, *Washington, D. C.*

HUNGER SIGNS IN CROPS. *Published by the American Society of Agronomy and the National Fertilizer Association, Washington, D. C. 1949. 390 pages.*

This second edition is more complete than the first. It is a book that should be on the shelf of every worker who deals with plants. The scope of the information given is extremely broad and comprehensive.

The chapter authors did an excellent job of bringing together a great deal of fundamental information about the factors that affect plant nutrition and growth. They also explain how the conditions that affect the growth of plants also affect animals and people. The relationship between different elements as they affect plant growth is an excellent feature of the book. Either deficiencies or excesses of one element may affect very vitally the use plants make of another.

In the field of the so-called minor elements, it is of interest that very small amounts of some of these are essential to the growth of plants and animals. When present in excessive amounts, however, they may be toxic. This information should be a valuable guide to those who might otherwise be inclined to make indiscriminate trials with certain of the minor elements whenever they encounter any unfavorable growth conditions.

The value of this book will be determined by the way it is used. Those who study the book and the conditions in the field where plants show deficiency symptoms will find it very useful. On the other hand, those who only compare leaves from affected plants with the illustrations in this book may make costly errors.

Some for example, will see in every discolored leaf a hunger sign and will diagnose the particular deficiency only by comparing the leaf with the illustrations in the book. Others will study the history of the field where the affected plants grew and learn what lime and fertilizers have been applied. They also will study the recent weather conditions and take into full account the effects of extremes in temperature and moisture. The season of the year and the stage of maturity of the crop will be considered. Plants will be examined carefully for signs of insect damage or disease.

The careful worker also will read all of the first chapter. "Why do plants starve?" and the chapter that deals with the particular plant under study. Where there is still doubt about diagnosis, he will either make tissue tests or arrange for them to be made.

Information in this book should be an excellent guide for proper soil treatment for the crop that is to be planted the year after deficiency signs are found. It is a more feasible practice to supply the nutrients needed to prevent deficiency symptoms than it is to correct them after they appear.

This review would not do justice to the book if the simple, readable style in which it is written were not mentioned. Even the deeply scientific portions are written in a style that can be understood by the lay worker who is not a highly specialized scientist.

—R. Y. Bailey, *Spartanburg, S. C.*

OUR SOUTH: ITS RESOURCES AND THEIR USE. *By* Everett F. Evans *and* Roy L. Donahue. *The Steck Company, Austin, Texas. 406 pp. Price $3.50.*

The economy, culture, resources, and problems of the

South have been the subject of many investigations and printed reports during recent years. The authors of *Our South* have drawn from these sources and from their own experience and brought together a mass of miscellaneous information on the nature, occurrence, and use of resources in thirteen southern states—Alabama, Arkansas, Florida, Georgia Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia. The book is printed in large type and is illustrated by a great number of tables, charts, maps, and photographs. It is a school text—possibly intended for the junior high school level. Mr. Evans is School Specialist in the Texas Forest Service and Mr. Donahue is Extension Agronomist at the Texas Agricultural and Mechanical College.

The first chapter is introductory and is titled "Our South." It discusses, among other things, population, education, health, and industry as they are related to problems of utilization and management of natural resources. Climate is treated in the second chapter not as a resource but as a factor affecting resources. These chapters are followed by others on minerals, soils, water, forests, grass, and wildlife. Each considers the use, management, local occurrence, and general nature of a resource.

The authors make liberal use of statistical data, often without adequately interpreting these data. There is considerable extraneous material and repetition is not uncommon. The chapter on soil devotes fifty pages to describing generalized soil regions for each of the southern states. These descriptions include statements on original cover and present land use but nothing as to capabilities or needs. The addition of this information would have made these fifty pages of more interest and use to the student. In the discussion of soil conservation and management the principle that soil must be used according to its capabilities and treated according to its needs is suggested in several places but never clearly stated or explained. This omission makes it a little difficult to understand and the discussion of the various soil conservation methods.

This textbook should, and undoubtedly will, receive widespread attention in southern schools. It will stimulate interest in our resources and in the ways they are and should be used. Teachers in grade schools as well as high schools will find it a useful source book.

—LAWRENCE V. COMPTON, *Fort Worth, Texas*

SOILS: THEIR PHYSICS AND CHEMISTRY. *By* A. N. PURI. *Reinhold Publishing Corp., New York. 550 pp. 1949.*

Here is a treatise on the chemical and physical behavior of soils. According to the preface, the book is intended for students in agriculture. Students in this country will find that they are prepared for it in about their fourth year of college work if they are chemistry majors, or after some graduate work or full-time research in soil chemistry or physics. For those who are directly concerned with laboratory work on soils, it is a book that will stimulate thought and discussion. Many will be inclined to disagree with some of the interpretations. For example, the author regards the soil acidoid as an insoluble, dibasic acid. The mono-acid salt, or saloid, is formed by titration with a strong base to a pH value four units higher than that of the acidoid. Base exchange capacity is equivalent to the total base required for the formation of the mono-acid saloid. Differences in the titration curves of different soil acidoids are noted but are not explained.

The first chapters, which deal with soil chemistry, make up Part I. Part II, 15 chapters, deals with mechanical analysis. Part III, 17 chapters, deals with soil moisture to the extent that it can be treated in a book that makes only a few references to field soils in place.

Those who are interested in field study of soils will be interested to note that the words "horizon" and "profile" do not appear in the index. The word "structure" does not appear, and "aggregation" appears once in a reference to state of aggregation as it governs the rate of electrodialysis.

Analytical methods and special apparatus developed by the author will be of more than passing interest. These include a siltometer, a chainohydrometer, and an attempt to reclaim saline soils by electrodialysis on a field-plot scale.

—J. G. STEELE, *Washington, D. C.*

AFRIQUE: TERRE QUI MEURT. *By* JEAN-PAUL HARROY. *Published by Marcel Hayez, Brussels. 1949. 2nd Ed. 557 pp. folded map.*

It is unfortunate that this book is availabe in French only, for it is a modern classic in the field of soil conservation. The subtitle—the wastage of African soils under the influence of colonization—gives the theme of the book, just as the title—Africa: bruised land—indicates the condition of the continent it describes. This second edition, five years after the book's first appearance, is paper bound but attractively printed on fine stock. One feels the lack of illustration, for there is only one photograph of a brush fire as a frontispiece. There is a folded map of major vegetation types of the continent. There is no index. There is a bibliography, and the author uses footnotes liberally for references to pertinent literature.

The book is exceptionally well organized, and the subject is treated in scholarly fashion. The work is divided into seven sections. First Harroy describes the formation and maintenance of African soils, with spe-

cial recognition of their relation to physiography, climate, and vegetation. The treatment is broad, but adequately sets the stage for the folowing sections. Next the author discusses the destruction of African soils, under the headings of the disappearance of vegatal cover, diminution of water resources, and accelerated erosion, with a description of the condition of the land resources in each of the continent's principal territories. The third section is devoted to the causes of the present situation. Here the author discusses fire, grazing and overstocking, agriculture and over-cropping. There follows a section of the change in the lives of the natives brought about by colonization, and its effects on their economic, political, material, social, and spiritual life. There is a section on the resulting change in the agricultural economy of the continent, such as restriction of nomadism and intensification of cultivation. The sixth section is devoted to means of improving the situation, and the final one to ways of applying the remedies.

In the United States, a people moved into a new land, destroying or isolating the natives, and by their efforts used the land to form and sustain a powerful new nation. In Africa the people of Europe imposed a culture and an economy not only on the land, but upon the natives as well. Perhaps for that reason, perhaps because the author is a first-rate ecologist, Harroy's treatment of land use in Africa differs from most such studies in this country by the close integration of land and social problems the author achieves. His approach is well exemplified by his section on proper means of relieving the situation, which he treats as remedies of the first, second, and third degrees:

1. Attend to the material manifestations of the trouble, by taking steps against the destruction of vegetation, loss of water, and erosion of the soil.
2. Reduce the effect of the intervention of man, by modifying the general methods of grazing and cultivation.
3. Look into the social, economic, and political conditions that contribute to the existing condition.

The author lists the place of scientific research and education in doing this job, and recognizes that government has a large responsibility in the management of the land and water resources on the continent.

Jean-Paul Harroy is in charge of Belgium's African research, and is a man of broad interests and objectives. His book is, so far as I know, the only comprehensive analysis of erosion and land-use problems on a continental scale. It is a carefully developed description of a great land area in bad shape, with comments on many of the factors—physical, biological, social—that have influenced the present situation, together with constructive suggestions for solution. The book seems as good a presentation of the case as one might require. Let us hope that it leads to active steps toward the resource rehabilitation of the Dark Continent. And let us hope, too, that the book will be translated soon, for it would take a conspicuous place in our conservation libraries if it were in our own language and, just as important, were readily available from one of our own publishers.

—Edward H. Graham, *Falls Church, Va.*

EFFICIENT USE OF FERTILIZER. *FAO Agricultural Series No. 9. Edited by Valdimir Ignatieff. FAO Washington, D. C.*

This little publication has been made possible through the contribution of a large number of technicians from various colleges in the United States, the Department of Agriculture and some foreign countries. It could very well be on the shelf or desk of every man working in technical agriculture. The book as a whole of course, was designed for FAO, and therefore should not be expected to be of particular value for application in any individual country.

The book is divided into seven major divisions with a final one dealing with the farmer and the help he might receive from the various agricultural services. Each major section is again broken down into various subsections which gives very good continuity to the major subject matter under discussion.

The chapter dealing with the role of fertilizers is only a few pages, but I think the authors have done an exceptionally good job in setting this out, particularly for farmer consumption. Also, the chapter on plant nutrients was very well put together for farmers the world over.

The chapter dealing on the necessity for organic matter gives a very good picture of this subject from a world viewpoint. In the preparation of this chapter the authors drew heavily on foreign practices where organic matter through composting, and the use of Night Soil, play such an important part in the argiculture of the respective countries.

There are a number of statements which might be questioned from a technical standpoint. For example, the statement is made that, "rock phosphate, because of its chemical nature, gives good response only on fairly acid soils. It is of little benefit to soils that are neutral to alkaline." It is possible that considerable discussion on this point could be had with many of the states, particularly Illinois, that have been using raw rock phosphate with lime for years. The definition of a rotation being "achieved when crops are grown in sequence," means nothing from the standpoint of soil fertility maintenance or soil conservation. The implication is also made that monoculture is not bad because yields can be maintained with heavy applications of fertilizer.

In Maine for example, such practices as growing potatoes continuously is justified because yields can be maintained with fertilizers. Nothing is said about the tremendous erosion that takes place under this type of agriculture, not only the erosion of the soil itself, but of the loss of fertility that is applied through commercial fertilizers.

Not all of the chapters, in my opinion, are of equal value to the readers. Chapter six, Crop Sequences and Fertilizers, does not have as much value in my judgment, as the other chapters for any particular individual, or give a man in any particular part of the world information which he can really use. At the end of each chapter a number of references are given for further reading if a man wishes to pursue the subject in more detail and has the availability of a good library or other reference material.

One thing which struck me about the publication is the lack of good pictures. A number are used but the photography is rather poor and the pictures don't tell the story well enough. Many of them of course, may have been taken by men who are amateurs in photography, even though they may be good technicians otherwise. I appreciate, of course, that the availability of good pictures to the editor may have been limited, otherwise he would not have been forced to have such a poor selection to choose from.

One of the most important features of this publication as I see it, is the utilization of many individuals as authors and consultants. This fact in itself lends authenticity to the book and thus might very well serve as a pattern or precedent for treatment of other subjects in agriculture.

—GROVER F. BROWN, *Washington, D. C.*

TWENTY-YEAR PROGRESS REPORT. *By* HENRY H. TRYON *and* RAYMOND F. FINN. *89 pp. Illus.. The Black Rock Forest. Bul. 14. Cornwall-on-the-Hudson, New York. 1949. $2.50.*

In general, forest research in this country labors under the handicap of piecemeal reporting. The continuous flow of morsel-size information from research organizations, Federal, State, forest school, and other, attests this. Seldom does an organization make the effort to review and sum up its findings. Even more rare an event is a review by an individual who for a generation has ably led an organization and can report its findings with skill and authority. H. H. Tryon has done so. In his paper jointly with R. F. Finn, is summarized the principal results of twenty years of silvicultural research at the Black Rock Forest in the Catskill region of New York. Written with quiet pride, it tells the reader both the conclusions and the means by which they were reached. In the main it is largely a record of Tryon's personal experience, in which he has directed his work and that of his associates towards the main objective of restoring a depleted forest to full productivity. The hardwoods on this area reduced to coppice were "... often defective and not infrequently growing on badly scorched soil." That he has done an excellent job is revealed by the scope of the studies and the breadth of the outlook.

The major part of the report deals with results of reforestation and improvement cuttings. Under conditions on the Forest, the former was found impractical, cost of releasing plantations from aggressive local pioneer species proving prohibitive. More practical were measurers designed to release local commercial species: "nature, if accorded an occasional bit of shrewd, observant help, will create the best crop—the most valuable and the most easily managed association."

According to the authors, the improvement cuttings necessary to replace coppice with seedling stock required a series of cleaning operations developing into shelterwood systm of management. From their account, this conclusion resulted from trial and error methods, capitalizing on the errors. The authors also report that a knowledge of the successional stages is a requisite to successful management of these areas. As not even a vestige of the original climax type remained on the Forest, this knowledge was developed only after detailed observation over a period of several years.

Accomplishments in mycorrhizal and soil nutrient research are briefly reviewed. The authors conclude with brief mention of other projects worth study together with some administrative details. If there can be criticism of the program, it would be that it was too comprehensive though one has difficulty in designating any phase as having only minor value.

Rather surprisingly, the authors did not mention the organization and history of research at the Forest or even present an outline map showing its essential features. The authors also have discussed cutting treatments and results by file numbers, a practice which certainly has nothing to commend it and can only result in confusion among many readers. The authors' own personal familiarity with the meaning of these designations is not matched by that of their audience.

Perhaps, the only real criticism is the failure to tie in plans with progress. While this report, by title, dealt with the latter, there is also a need in this type of report for describing what comes next, if for no other reason than to maintain continuity between reports. Undoubtedly, the authors have very definite plans. Their inclusion would allow an accounting of past progress and plans for the future in light of the research objective.

The list of publications from the Black Rock Forest printed on the inside front and back covers of this bul-

letin is ample evidence of progress reported between covers. Since 1930, 14 bulletins and 23 papers have reported research results. Consistently carrying the mark of high-caliber research, they are indicative of progress described in the bulletin. Director Tryon and his associates are to be congratulated for worthy achievements well documented.

—Howard W. Lull *and* E. N. Munns, *Wash., D. C.*

Effect of Rodents, Rabbits, and Cattle on Two Vegetation Types in Semi-Desert Range Land. *By* J. J. Norris, *New Mexico Agricultural Experiment Station, Bul. 353, State College, New Mexico. 23 pp.*

The effect of eight to twelve years of protection of two "types"" of semi-desert range from cattle, rodents, and rabbits are reported. The annual yield of forage in both types increased under all treatments, indicating that relief from grazing by either class of animals was a significant influence for range improvement. Rodent and rabbit effects were much more important in the *"mesquite-smokeweed"* type than in the *"black grama grassland type"*. The former is a deteriorated phase of the black grama climax. Thus is documented another instance of the dependence of high rodent populations on range abuse. The author interprets the results with an ecological insight all too rare in writing on the rodent problem in the western range.

Trees and Shrubs for Erosion Control in Southern California Mountains. *By* Jerome S. Horton, *California Department of Natural Resources, Division of Forestry —In cooperation with U. S. Forest Service, California Forest and Range Experiment Station. 1949. 72 pages, 27 illus. Bibl.*

Many areas in the southern California mountains are eroding actively. The principal erosion sources are: Road slopes, landslip scars, burned areas, gullied meadows, stream channels, and sparsely vegetated areas. Control of erosion presents different problems in each source area. Erosion on some can be reduced simply by planting trees and shrubs; some areas require mechanical stabilization before planting, and others require engineering structures. Such factors as soil, temperature exposure, precipitation, and animal activity determine the species to use and the proper methods of establishing a cover. Effective erosion control requires the establishment of a permanent cover or an association of plants that will occupy the site until conditions have become favorable for invasion of native vegetation. Fifty-eight species of trees and shrubs are recommended for erosion-control planting in the southern California mountains. They are listed according to the types of planting sites to which they are adapted. Planting experience, recommended use and planting methods are discussed for each of these species.

Ecological Bases for Planning

(*Continued from page 62*)

Areas in Swamp and Coastal Marsh

Swamp succeeds Paille fine marsh in the eastern phase, and so will not be discussed here.

On the basis of careful studies by the Soil Conservation Service there are 5,091,000 acres of Western Gulf Coast marshlands. Of that area, 2,333,000 acres are best adapted to, and most safely and profitably used for wildlife purposes. A total of 1,989,000 acres may be used safely and profitably for livestock range. The remaining 769,000 acres may be suitable for miscellaneous uses, but they are virtually waste lands at present. Parts of the area now considered as wastelands, as well as parts of the area suitable for range, might be best used for wildlife. Land suitable for cultivation is relatively insignificant. Of the total area of marshlands 517,989 acres are publicly owned and are mainly in wildlife refuges.

LITERATURE CITED

1. Plant Communities in the Marshlands of Southeastern Louisiana. Wm. Penfound and Edw. S. Hathaway. Ecol. Mono. 8:1-56. Jan. 1938.
2. The Vegetation of the Bay of Fundy Salt and Diked Marshes. W. F. Ganong. Bot. Gaz. 36:161, 280, 349, 429. 1903.
3. The Relations of Plants to Tide Levels. D. S. Johnson and H. H. York. Carn. Institute Wash. Publ. 206. 1915.
4. The Vegetation of the Salt Marshes of Northern Coastal New Jersey. J. W. Harshberger. Proc. Acad. Nat. Sci., Phila. p. 373. 1909.
5. Plant Communities of the Coastal Plains of North Carolina and their Successional Relations. B. W. Wells. Ecol. 9:230-242. 1928.
6. Food of Game Ducks in the United States and Canada. A. C. Martin and F. M. Uhler. U. S. D. A. Tech. Bul. 634. March 1939.
7. The Fur Animals of Louisiana. Stanley C. Arthur. Louisiana Dept. of Cons. Bul. 18, Jan. 1931.
8. Muskrats on the Texas Coast. Daniel W. Lay and Ted O'Neil. Jour. Wildl. Mgt. 6(4):301-311. October 1942.

Conservation — A Brief Appraisal

(*Continued from page 56*)

relationship to our problem. One is science, the other private enterprise.

Only by the widest diffusion of scientific understanding can we be brought to realize our obligations as a part of nature. Only when technologists have the kind of scientific training which enables them to grasp the world of nature in its entirety, instead of in closed segments, can we develop the means for making conservation effective.

So far as private enterprise is concerned, its freedom always has been, always must be a relative thing. But its largest measure of continuing freedom can only be won by an honest responsibility for the preservation of our capital structure in terms of natural resources. Not the highest immediate profits but the guarantee of sustained returns must be the goal of our economy.

Recent Research Reviews

JAMES H. STALLINGS

Movement of Nitrogen in Flooded Soil Planted to Rice. *By* WILLIAM H. WILLIS *and* VICTOR E. GREEN, JR.; *Soil Sci. Soc. of Amer. Proc., Vol. 13, pp. 229-237. 1948.*

A study of the nitrogen changes that take place in flooded soil planted to rice has been conducted in the greenhouse using two soils from the Louisiana rice area.

Ammonium-nitrogen accumulated in the flood water on the planted soils in quantities up to five ppm during the first two weeks of flooding. The ammonium-nitrogen content then decreased during the next three weeks, the time of most vigorous growth of the plants. This decrease did not occur on the unplanted soils. The presence of algae growing in the water and the applications of fertilizer to the soil had no effect on the reaction, ammonimum-nitrogen, or nitrate-nitrogen content of the flood water. There were net gains in nitrogen in both soils during the growing season where the crop was present except in the Crowley soil where nitrogen had been applied.

The results of this study indicate that gains in nitrogen as a result of fixation under the conditions prevailing in rice fields during the growing season may be equivalent to or greater than the amount of nitrogen utilized by the crop. Highly significant gains in nitrogen in the absence of the crop occurred only in the acid soil where relatively large quantities of phosphorus and potassium had been applied. Heavy losses of nitrogen occurred in the soils with high nitrogen contents in the absence of the rice crop. In both planted soils increased fixation in the presence of algae occurred only in the checks. No relation was found between the ammonia content of the flood water and the gains or losses in nitrogen in the system. Changes in total-nitrogen content were not related to changes in pH of the soil or of the flood water. The immediate crop did not fully utilize the nitrogen gained by fixation and responded highly to the nitrogen applied to the soil in the ammonium form.

The Characterization of Slope Positions and their Influence on the Total Nitrogen Content of a Few Virgin Soils of Western Iowa. *By* ANDREW R. AANDAHL; *Soil Sci. Soc. of Amer. Proc., Vol. 13, pp. 449-454. 1948.*

The principal aim of this study was to obtain some measure of the thickness and organic matter content of the A horizon associated with different slope positions. It was believed that the A horizon varied not only in depth, but also in quality, quality being measured by organic matter or nitrogen content.

A simple inspection of the data indicates clearly that there are big differences both in the total nitrogen of the profiles and in the per cent nitrogen of any given horizon. Many of these differences could be recognized in the field by the color of the soil. The nitrogen contents of all profiles collected near the tops of the ridges were low compared with those on the lower slopes. An examination of the data with regard to the influence of the length of slope on the average per cent nitrogen indicates that there may be a rather close relationship. A thinner soil is normally formed on steeper slopes but the other slope characteristics often upset this relationship.

The Collection and Study of Natural Soil Cores for Determining Irrigation Properties. *By* ALBERT W. MARSH *and* L. R. SWARNER; *Soil Sci. Soc. of Amer. Proc., Vol. 13, pp. 515-518. 1948.*

Natural soil cores were cut from certain problem soils on the Owyhee Irrigation project in eastern Oregon. These cores were wrapped in alluminum casings and transported to the laboratory. After some preparation, including the insertion of manometers, the cores were placed in a rack. Percolation trials were run to determine the permeability and the relative resistance of the various portions of the profile. Some results are reported showing the varying permeability between individual cores and between soil groups. The least resistance to water penetration tended to be at or near the surface, the greatest resistance in the subsoil just above the compact section. These cores are useful also for obtaining soil samples by horizons necessary for the determinations of volume weight, moisture-tension curves, salinity, exchangeable bases, mechanical analysis, and 15-atmosphere moisture percentage. Certain advantages and disadvantages of the alluminum casings are pointed out. A suggestion is made that the disadvantages could be overcome by the use of transparent plastic containers for laboratory permeability measurements.

Soil Zones of the Great Plains States—Kansas to Canada. *By* JAMES THORP, B. H. WILLIAMS, *and* W. I. WATKINS; *Soil Sci. Soc. of Amer. Proc., Vol. 13, pp. 438-445. 1948.*

The soil zones of the Great Plains are aligned in a generally north and south direction corresponding to climatic belts. Prairie soils lie in the easternmost part where Thornthwaite classifies the climate as moist-subhumid. The Chernozem soils, and some of the Chestnut soils, lie within Thornthwaite's belt of dry-subhumid climatic belts. Prairie soils lie in the eastern-most part boundary of Chestnut soils in some places and lies considerably farther east in other places. Generally, the drier part of the Chestnut soils zone is within the eastern

edge of Thornthwaite's semi-arid climatic belt. Thornthwaite's semi-arid belt embraces all of the zone of Brown soils, and in addition, a small area of Sierozem soils in southeastern Colorado. Along the foothills of the Rocky Mountains the westward trend toward aridity is reversed. The semi-arid parts of the Great Plains grade first into dry-subhumid areas just east of the mountains, then rapidly through a moist-subhumid zone into humid climates in the mountains. Corresponding reversals in vegetation types and soils, from one end of the Rocky Mountains to the other, exemplify the phenomena commonly called vertical zonation. A similar reversal of soil and vegetation zones may be seen around and into the Black Hills, and the smaller isolated mountains of central Montana.

The Shearer "Trash Culti-Seeder." *By* R. I. HERROIT. *Power Farming, Vol. 58, No. 10, pp. 17-19, Sydney, Australia. October 1949.*

John Shearer and Sons have perfected and produced a machine which they claim will (a) leave straw or trash on the surface and which is also suitable for sowing and renovating pasture lands; (b) anchor straw or trash, thus preventing wind and water erosion and increase water absorption; and (c) which is choke-proof even in the most dense stubble and trash. The machine and its use are described and illustrated.

Composition of Alluvial Deposits Viewed as Probable Source of Loess. *By* ALVIN H. BEAVERS *and* WM. A. ALBRECHT; *Soil Sci. Soc. of Amer. Proc., Vol. 13, pp. 468-470. 1948.*

As a collector, mixer, and depositor of the material which it carries, according to the evidence, the Missouri-Mississippi River system is bringing about uniformity of its sediment throughout its course. Therefore, the barren river flood plain, swept by winds that pick up certain separates of the sediments and re-deposit them on the upland would make such deposits, of necessity, consist of material that is relatively constant in mineral and chemical makeup.

According to these data, then, the relative mineral and chemical uniformity of loess over wide areas is not due to any specific part played by the wind. Rather, it seems plausibly explainable as the result of the action of a river, in bringing about uniformity of its sediments left in its flood plains to be picked up by the winds and deposited as loess. Soils developed from loess, then would vary according to the climatic factors operating in any specific location.

Rating Soils for Timber Sites. *By* EARL STORIE *and* A. E. WIESLANDER; *Soil Sci. Soc. of Amer. Proc., Vol. 13, pp. 449-509. 1948.*

This paper reports on studies started in 1948 at 163 field locations extending from the Pacific Ocean to the east side of the Sierra Nevada mountains in Nevada on the relationship of soils, climate, and timber site quality. The soils were studied at each location, then classified, and the timber site quality determined by refering the height and age value to appropriate site class curves.

Four main soil factors appear to govern or limit the growth of conifers in California. These are (a) soil depth and texture characteristics; (b) soil permeability; (c) soil chemical characteristics; (d) drainage and runoff properties. In addition there is the climatic factor.

High sites for growing conifers in California need a deep soil of sufficiently fine texture to hold about 12 per cent or more of moisture; a permeable profile; have no toxic chemical characteristics; be of acid reaction; well drained; and have a total annual rainfall of more than 40 inches

Preliminary timber rating chart is presented based on assigning percentage ratings to five factors; (a) soil depth and texture; (b) soil permeability; (c) soil characteristics; (d) drainage and runoff properties and (e) climate.

What's Under the Trees? *By* HERBERT A. LUNT. *Frontiers of Plant Science, Vol. 11, No. 1, p. 3. November 1949.*

Forest type and soil maps are essential to modern timber management. There is a growing recognition of the importance of the soil beneath the trees and the role it plays in determining the character of the stand and its yield in lumber or cordwood. Like any farm crop, trees need moisture and plant food from the soil. Moisture relations may be indicated by the soil type. In some instances moisture condtions vary within a given soil type because of topographic position. A five-year-old planting of white pine on Hartford sandy loam grew 27 per cent faster than in identical planting on Merrimac loamy soil not more than 350 feet away. The increase with Norway spruce was even greater—nearly 90 per cent. Here the difference was not one of soil series such as—Hartford vs. Merrimac—but rather that of soil texture and moisture supply. The substratum of the Hartford sandy loam was considerably more moist and the tree roots penetrated to a greater depth than on the block of Merrimac loamy sand.

How Nutrients Removed from Soil by Harvested Crops are Replaced by Fertilizers. *By* A. L. MEHRING *and* R. Q. PARKS; *Agr. Chemicals. October and November 1949.*

This paper is devoted primarily to a summary by regions and states of the 1947 data for nitrogen, phosphoric acid and potash removal by harvesting crops and additions by applications of fertilizer and manure. The relative importance by regions of other factors relating to fertility trends is discussed briefly.

Abstracts —

Competition Between Sagebrush and Reseeded Grasses. *By* BLAISDELL, JAMES P. *Ecol. 30(4):512-519. October, 1949.*

Reseeding grasses one or two years before or in the same year sagebrush was seeded on replicated plots in Idaho consistently resulted in greater growth by the grasses than by the sagebrush. "Good stands of grass often prevented subsequent establishment of sagebrush seedlings. Where sagebrush seedlings did invade the stand, they were very much suppressed." Sagebrush yields were much greater than grass on plots seeded to grass two or three years after sagebrush.

The results of this study are of vital practical importance to the program of reseeding and managing depleted sagebrush-grass ranges of the Intermountain region. Of wide significance is the concrete demonstration that, in at least one instance, grasses did prevent the establishment of brush seedlings—a principle widely claimed by range managers on a theoretical basis but as yet not experimentally proved. If this result can be verified for juniper, mesquite, and other rampant brush species of the southwestern savannahs, a big step will have been taken in placing advocated range practices on a firm experimental basis.

Primary Succession in 1792. *By* BUELL, MURRAY F., *1949. Ecology 30(1):107-108. Jan.* (*Note*)

A translation of a paragraph from Willdenow's *Grundriss der Krauterkunde,* originally published in 1792, shows that the concept of plant succession, which is the basis of most modern wildland management, is by no means recent. This brief but lucid passage is worth the trouble of consulting it here, if one cannot read the German original.

Cheatgrass (*Bromus tectorum L.*)***—An ecologic intruder in Southern Idaho.*** *By* STEWART, GEORGE, *and* HULL, A. C., *1949. Ecology 30(1):58-74. Jan.*

Cheatgrass is an example of an inferior forage plant that has invaded millions of acres of abused native range. Once established, it brings an added fire hazard that virtually assures the completion of its conquest. What has happened here is a warning to range users in the rest of the West to guard their original grass stands against intruders. This paper summarizes the present knowledge about cheatgrass, and states a management policy to deal with the present situation while looking to re-establishment of the perennial grasses.

Soil-Root Relationships of Certain Native Grasses in Various Soil Types. *By Weaver, J. E., and Darland, R. W. Ecol. Monog. 19 (4): 303-338. Oct. 1949.*

Detailed descriptions and measurements of the roots of 11 species of grasses in 16 soil types from the True Prairie in Nebraska are presented. To most readers, the superb photographs of the root systems, after they had been washed free from monoliths of soil, will be the most informative part of the paper.

Studies of Bluebunch Wheatgrass in Montana and Height-Weight Relationships of Certain Range Grasses. *By* HEADY, HAROLD F. *Ecol. Monog. 20 (1): 55-81. Jan. 1950.*

Determining the percentage of forage utilized by livestock from range areas is a key procedure in management. How to do this is one of the most perplexing problems of range conservation. One method uses the predetermined "height-weight" relationships of key plants to calculate from observed stubble-heights the percentage of weight removed by grazing animals.

This study presents height-weight tables for bluebunch wheatgrass and four other species from different sites in different years and analyses various features of the data. The author's conclusion is that this method has greatest value for training technical personnel and for use in experimental studies.

A series of drawings showing the root patterns of bluebunch wheatgrass in relation to the lime zone in soils will bear comparison with photographs of roots of True prairie grasses by Weaver and Darland, mentioned elsewhere in this section.

Seed Production of Native Grasses under Cultivation in Eastern Kansas. *By* CORNELIUS, DONALD R. *Ecol. Monog. 20 (1): 1-29. Jan., 1950.*

Experiences in collection of seed of native grasses from natural stands, and production on the S.C.S. nursery at Manhattan, Kansas, during the 9-year period, 1937-1945, are summarized and compared. Results of experiments with fertilizing, spacing, planting methods, burning and mechanical renovation of sod-bound stands are also reported. Nitrogen fertilizer increased production of cultivated stands, and burning increased subsequent seed production of all species except buffalograss.

Effects of Thirty Years of Protection from Grazing in Desert Grassland. *By* GARDNER, J. L., *Ecol. 31 (1): 44-50. January 1950.*

After 28 years without grazing, the grass density on upland in a 320-acre tract near Silver City, New Mexico, was 110 per cent higher in 1946 than on a comparable site outside. There was little difference, however, in species composition. Two years later, following draught in 1947 and 1948, grass density had decreased 75% both inside and out of the area. This is a unique report on a large "exclosure" in semi-desert grassland and indicates how painfully slow ecological improvement of rangeland can be, even with complete protection, in this climate.

—*Contributed by* BEN OSBORN

(*Continued on page* 94)

FIELD NOTES AND COMMENTS

Five Thousand Texas Boys Learn Grasses Through Judging Contests

If you had attended one of the livestock shows the past fall and winter in Dallas, Fort Worth or Houston, you would have seen how Texans got about five thousand boys to take an interest in what they say is the State's greatest crop—*grass*. At each of these shows there was a grass judging contest in which *each boy was given a minute to name a range grass and then to check whether it is an annual or perennial, native or introduced plant, give its season of growth and an estimate of its range value*. It's a grand sight watching a hundred or more boys at one time working like beavers over the most important and most neglected and abused crop in the world—*grass*.

The Texas Association of Soil Conservation Districts and respective State Fair and Stock Show managers sponsored the grass judging contests. The sponsors were given an immense amount of help by the Texas Extension Service, Vocational Agricultural Department, and Soil Conservation Service who prepared the grass exhibits and trained the boys.

—Waters Davis, Jr., *Fort Worth, Texas*

Careful Planning Brings Results In Louisiana Tree Planting Program

Ten years ago it would have been a hard job to convince a Louisiana or Arkansas farmer he ought to plant trees on some of his land. He had never thought much about trees as a cash crop.

The story is different now. More and more farmers in the timber belts of Arkansas, Louisiana, Texas and Oklahoma are seeing the value of growing trees as a crop in their soil and water conservation program. This realization has resulted in the biggest year of tree planting the pine belt of these states has ever known. Farmers cooperating with soil conservation districts planted more than 17 million pine seedlings on 24,000 acres during the 1949-50 planting season. There is every indication that this is only a beginning.

Farmers in the D'Arbonne Soil Conservation District in northern Louisiana planted 3,500,000 pine seedlings, the biggest planting for any district in the Western Gulf Region.

The primary reasons for the increase in tree planting are:

1. Witnessing the profitable management of scattered plantations established in the early days of the districts and in natural woodlands has sold many farmers on the value of timber as a crop.

2. The judicious use of forestry specialists. This tends to keep the forestry phases of coordinated land use in proper perspective.

3. The widespread use of tree planting machines which do a job that could not be done with scarce farm labor.

4. Available planting stock.

—H. C. Mitchell, *Fort Worth, Texas*

School Forest in Arkansas Operated by Vo-Ag Students

Vocational agriculture students at Bradley High School in southern Arkansas are learning about conservation woodland management by running a forest themselves. Mayor F. M. Cochran of Bradley made is possible by giving the school a 30-acre woodland.

Instructor T. E. Cason and his students worked out a plan with the Terre Rouge-Bodcaw Soil Conservation District to get technical training in woodland management. The students operate the land as a business, their conservation plan putting emphasis on timber as a crop to be harvested annually.

Twenty acres of the woodland were divided into five equal sections. The boys mark and selectively cut one section each year. Records will be kept on growth and yields. Eight acres were planted to pine seedlings and another two-acre section will be kept as a check plot to contrast timber growth on a mismanaged woodlot with that of selectively-cut plots.

The Bradley High School plan is the first of its kind in Arkansas, but schools in other parts of the state are interested in the idea. The Bradley plan for practical on-the-farm training for its agriculture students may soon be in effect in many other progressive vocational schools.

—J. M. Case, *Hope, Arkansas*

Industry Sponsored Conservation Camp Successful in Wisconsin

"The first annual Marshfield Tri-County Soil Conservation camp, attended by delegates from Wood, Clark, and Marathon counties, opened this morning in the Youth Fair Building at the fair grounds.

"The camp, sponsored by the Lloyd L. Felker Company, is unique in the respect that it is probably the first time that a local business organization has attempted to do something about the soil conservation problem."—

Photo by Marshfield News Herald

A field crew pauses in terrace construction to evaluate the effects of up-and-down hill cultivation and the lack of adequate water disposal

from the Marshfield, Wisconsin, *News Herald,* September 13, 1949.

The camp, attended by thirty young farmers, grew out of ideas submitted by agricultural leaders in the three-county area working with Edward Hill of the U. S. Soil Conservation Service. Stated objectives of the camp were to develop a greater appreciation of soil conservation, to show how health is related to soil management practices, and to develop skills in soil conservation technique.

County agents and vocational agricultural instructors selected ten representatives from each of the three counties, on the basis of their ability to work with people, promote soil conservation among their neighbors, and sustain interest in the welfare of their community and its farm families. Many of those selected were youths prominent in 4-H and F.F.A. activities, some were veterans.

The first day was devoted to registration, a general introduction to soil conservation, and organization into 5-man field crews; also a field trip to the neighborhood of the Little Trappe Farm Improvement Association, where the application and value of farm conservation plans with farmers was discussed.

Classroom instruction in the use and care of the engineer's level began the second day's activities. Following this, the crews, each under the supervision of Soil Conservation Service technicians, practiced using the level and staking terrace lines on sites where terraces were to be built. Each man was given the opportunity to run the level and carry the rod so that he became familiar with the mechanics of terrace layout.

The third and fourth days' activities were started with one hour sessions in the classroom on the procedures to follow in building terraces with the farm plow and such other machinery as might be available. After the classroom work the crews started construction of the terraces they had staked out. Crew members alternated in driving the tractors, which were furnished by local farmers and implement dealers. Some work was done with the whirlwind terracer and the motor patrol grader to familiarize the students with such equipment.

Considerable time was saved for constructive work by serving hot lunches in the field. Marnite cans, made available by the local National Guard Company, facilitated this task.

Finally, a critique was held on the work accomplished, followed by a dinner at one of the local "steak" houses. Supervisors of the three districts, businessmen and civic leaders, were invited for the evening's program, climaxed by the presentation of appropriate certificates signifying completion of the course.

The supervisors expected that the camp would contribute to an increased desire on the part of farm operators to apply soil conservation practices, speed-up of application of conservation practices, part-time help for soil conservation districts, strengthening of rural-urban relationships, opportunity for the older 4-H and F.F.A. members to develop and exercise leadership qualities, and more youth interest and participation in 4-H and F.F.A. programs related to soil conservation.

The results anticipated were in part borne out by what was done after the close of the camp. Each candidate submitted to his county agent his plans for getting more conservation accomplished on his farm and in his neighborhood. Some outlined plans for test plots to sell their parents on proper use of fertilizers, pasture renovation measures, etc. Others told of plans for constructing water disposal systems. Some suggested improvements for future courses.

One month after the close of the camp the men were asked to submit reports showing what they had done. From samples of reports read, the area is much better protected from erosion now by more than 29,000 feet of terraces and outlets. Based on the reports, two representatives were then selected from each district to attend a 2-day inspection trip of the Goodyear plant in Akron, Ohio, sponsored by the Felker Company and Goodyear. This trip was of immeasurable value to this agricultural community.

The author, who served as classroom instructor and trained one field crew at the camp, feels that the local sponsors have established a pattern, which if followed by similar groups over the country would materially

speed up the rate at which soil conservation can be applied to the land.

—ARTHUR W. KOWITZ

Good Field Day Planning Pays Off

You have to have something interesting and worthwhile to show and then set the stage by careful planning if you are going to have a successful conservation field day.

That is what the Upper West Fort Soil Conservation District had and did in Texas last summer. Fifteen hundred farmers, ranchers and business people confirmed it by their lively interest and enthusiastic comments when they turned out a few weeks later to see the hip-high bluestem, small runoff water control structures and other successful agricultural flood control measures in the upper reaches of the Trinity River east of Jacksboro.

It all boiled down to the fact that the district Supervisors allowed themselves enough time to make most of their mistakes on paper. And this is how they managed it:

1. After deciding on a date with the best prospects of good weather when the conservation measures would show up to best advantage, they selected a theme: *"Control of Upstream Floodwaters by Keeping the Raindrop Where It Falls."*
2. An invitation list was prepared, and invitations were sent out early.
3. Speakers for the program were chosen, and invitations and information about the field day were sent to them early enough to aviod having to make last-minute substitutions.
4. Supervisors and selected field day leaders went over the ground, deciding on tour stops and other points of interest to be included.
5. Definite planning responsibilities were assigned to key ranchers, with meetings held with them often enough to check on progress and with farmers on the tour route visited well in advance by a district representative and a leader.
6. The County Commissioners' help was obtained in making needed road repairs along the route.
7. Committees were set up early for each important job, such as information material, publicity, tour arrangements, and food, each consisting of a district supervisor, a community leader and a technical man, with one supervisor selected as coordinator for all the committees.

Committees to assist during the day included: welcome (Chamber of Commerce), information booths, transportation, speakers stand and chairs, sound trucks, drinking water, tour guides, gate watchers—4-H and FFA boys—signs, posters and information material, special guests, food, and fire-

Figure 1. Part of the crowd that turned out to see the small runoff water control structures and otner succesrui agricuitural flood control measures.

watch. One of the informational-material committee members was picked because of his experience in dealing with artists and printing companies.

8. Qualified men were chosen for the discussions at all tour stops, and written guide talks were prepared and each person's spiel passed around to all the others so that the whole story would be complete.

The pay-off on this careful planning came on the day of the tour. The weather was fair; the tour moved fast in relays; the route was well marked, and no delays were caused by visitors' getting lost; and there was something to entertain the visitors from the time they arrived at the site of the speaking program—grass exhibit, band concert, the dam at the site, speakers all on hand with something to say, and a piping hot barbecue lunch ready to serve.

The field day was a success.

—J. C. PORTER, *Jacksboro, Texas.*

Kordite—A Superior Layout Cord

In our work as technicians, we often felt the need for a more satisfactory type of cord for measuring the parallel boundaries for contour strip cropping. The cotton cash cord used for this purpose had too many faults. A material that was durable, light in weight, was not subject to shrinking or stretching—depending upon moisture conditions was needed. It should not whip in the wind and should not become water-logged or collect mud and dirt.

Other than sash cord, many other types of material had been used, such as steel tape, metallic cloth tape, binder twine, mason's cord and fish line, but they all had one disadvantage or another.

After shopping around for some time a new type clothesline material called "Kordite" was purchased for $1.95 for 100 feet. This material has been used through one strenuous layout season and is by far the best type of cord yet found for the purpose.

Kordite consists of three very fine, flexible strands of wire for a core. These strands of wire are wrapped with a rayon cord which in turn is covered with a thin coating of white plastic material. The cord is about one-quarter inch in diameter and light in weight.

Permanent markers were made at ten foot intervals by wrapping a few turns of string very tightly around the cord and covering this with black tape. Strip widths vary from 60 to 100 feet, depending upon steepness of the slope. These marks on the tape make it possible for us to quickly make a temporary loop in the cord at the correct length. The loop serves to shorten the cord and makes a convenient temporary "handle" on the end of the cord. A more permanent "handle" for the other end is made simply by forming a single loop and binding the loose end against the cord with string.

The new layout cord has been used steadily for four months and it still retains its white color and original length. It remains flexible, even in sub-freezing temperatures. In brief, the advantages found in Kordite cord as a tool in laying out strips are: it is durable, light in weight, has little wind resistance, neither shrinks nor stretches and does not become water logged.

—JACK HARPER, *Portage, Wisconsin.*

Land Policy Must be Far Reaching

"The land policy of the United States up to the turn of the century was primarily one of transferring the public domain to private ownership as quickly as possible and leaving desirable adjustments to be worked out by the forces of competition. Little consideration was given to the uses for which lands were best adapted, or to the effective demands for products of the land. . . . It is now felt that an adequate land policy must provide not only for the preservation of soil fertility but also for the directed adjustment of production to demand, the economic utilization of marginal lands, and the maintenance of a balance among the various segments of the economy."

—ROLAND R. RENNE, *in Land Economics.*

The Coming Age

". . . The period of exploration and unsystematic, sporadic advance, which seemed to the nineteenth century to embody the essential characteristics of the new economy, is rapidly coming to an end. We are now faced with the period of consolidation and systematic assimilation. Western civilization as a whole, in other words, is in the condition that new pioneering countries like the United States found themselves in, once all their free lands had been taken up and their main lines of transportation and communication laid out: it must now begin to settle down and make the most of what it has. Our machine system is beginning to approach a state of internal equilibrium. Dynamic equilibrium, not indefinite progress, is the mark of the opening age: balance, not rapid one-sided advance: conservation, not reckless pillage."

—LEWIS MUMFORD, *in Technics and Civilization*

Controlling Water on the Land

(*Continued from page 76*)

nually produce 1.5-2.0 tons of litter per acre per year which is converted by climate and soil fauna and flora, into humic material. Indeed so active is the soil fauna, that in ten to 20 years enormous amounts of mineral soil particles are brought up from deeper soil layers and mixed with the plant remains. In this period of time a humic material may be built up on bare soil to a depth of six or eight inches. This material, to all intents and purposes a soil, has a high infiltration rate and a great water retention storage and temporary water holding capacity.

The importance of the effect of organic matter as a soil builder is shown by the results of recent observations in New England. A four inch humus layer rich in organic matter was found in a woodland protected for 20 years. In an adjacent grazed area the humus was two inches deep and contained by comparison but little organic matter. A computation showed that the four inches of good humus layer had increased the soil depth by 2.5 inches. As the mineral soil mantle was about 16 inches thick, this represents an increase in soil depth of over 15% in 20 years. The storage capacity of the mantle was increased by 18%. This method of increasing storage capacity has not been given the general acceptance it deserves, except by foresters.

Our discussion has pointed out some of the more important soil-water relations and how they affect runoff. We have had to generalize because a more complete discussion would require a considerably longer discussion. We believe however that a full consideration of the factors outlined here will give the conservationist an opportunity to understand that runoff from the land can be controlled by the use and manipulation of vegetation.

LITERATURE CITED

1. Fletcher, Joel E. and Martin, W. P. Some Effects of Algae and Molds in the Rain-Crust of Desert Soil. Ecology, Vol. 29, No. 1. Jan. 1948. pp. 95-100.
2. Alderfer, R. B. and Robinson, R. R. Runoff from Pastures in Relation to Grazing Intensity and Soil Compaction. Journal of the American Society of Agronomy 39(11): 948-958. Nov. 1947.

Drainage in Conservation Farming

(*Continued from page 79*)

plex technically. The urgency of action together with the impediment of technical complexity makes essential the design of new tools to aid the engineer in efficient and effective drainage design.

It is squarely up to soil conservationists in all walks of life to encourage and support not only the application of drainage on agricultural lands, but, more basically, to support the research necessary to speed up and develop a sound and economical program of drainage in conservation farming.

LITERATURE CITED

1. Estimates from Report of Committee on Drainage, ASAE, 1946.
2. Uhland, R. E., Soil Permeability—Mimeographed Report (In-Service) Soil Conservation Service, Washington, D. C.—March 1949.

Some European Conservation Problems

(*Continued from page 70*)

6. Loddesol, A. "Soil Conservation Problems in Norway." Paper presented to United Nations Scientific Conference on the Conservation and Utilization of Resources, August-September, 1949. Lake Success, New York.
7. Oliva, A. "Le Sistemazioni dei Terreni." 1947 Edizioni Agricole. Bologna, Italia.
8. Passerini, G. "Per la difesa del suolo, vecchie applicazioni e problemi nuovi." 1946. Agricultura Toscana (Genn. Febbr.) Firenze, Italia.
9. Riddell, G. E. "Land is Clear in Italy" The FAO European Bulletin, Jan.-Mch. 1948. Villa Boghese, Rome, Italy.
10. Russell, E. F. "Guard against soil erosion." Farmer and Stock-Breeder, Mch. 1, 1949. London, England.

"The best cure for the ills of overgrazing is to be found in the natural recuperative power of grasses and the chief task is to afford them a fair opportunity. Natural recovery is so much more automatic and economical than restoration by sowing or planting that it should always be given an adequate test before artificial methods are used."

FREDERIC E. CLEMENTS, *in Dynamics of Vegetation.*

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In the NITRAGIN greenhouse, scientists check the effectiveness of different strains of legume bacteria. Comparison of data gained from laboratory analysis of the nitrogen-fixing ability of each bacterial strain, permits the selection of the most effective strains for use in NITRAGIN inoculant. Continuing research in the NITRAGIN laboratories helps to further conservation . . . by increasing the value of legumes and inoculation as a means of holding the land and reducing erosion. NITRAGIN is always glad to cooperate with scientists working in this field.

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Abstracts

(*Continued from page* 88)

Piezometers for Ground-Water Flow Studies and Measurement of Subsoil Permeability. *By* REEVES, R. C., *and* JENSEN, MAX C. *Agricultural Engineering Journal 30 (9): 435-438. September 1949.*

Technical article of particular interest to persons dealing with drainage problems. It gives the methods of installing piezometers and permeability determinations derived by their use.

Measurement of Soil Moisture by the Electrical Resistance Method. *By* BOUYOUCOS, G. J., *and* CRABB, JR., G. A. *Agricultural Engineering Journal 30 (12): 581-583. December 1949.*

Here is a field method for determining soil moisture by electrical resistance. Good results have been obtained generally except in areas containing large amounts of salts in the soils.

Runoff Estimates Based on Infiltration Capacity, Antecedent Moisture Conditions and Precipitation. *By* ANDREWS. *Agricultural Engineering Journal 31 (1): 26-28. January 1950.*

This technical article should be of interest to engineers, hydrologists, and others who make estimates of runoff. There is also an interesting discussion by Mr. L. K. Shuman, Mr. Edgar E. Foster and Mr. W. W. Horner at the conclusion of the article.

—*Contributed by* JACK GRIFFIN

Erosion Pavement, Its Formation and Signaficance, by LOUDERMILK, W. C. *and* SUNDLING, *H. L. 1950. Trans. Amer. Geo. Union 31 (1): 96-100 Feb.*

Erosion pavement is the technical term given to the accumulation of rock fragments on the surface of the soil after the finer soil particles have been eroded. It forms on the surface of bare soil after the removal of the protective mantle of vegetation.

This paper describes an experiment with lysimiters showing the formation and the effect of the erosion pavement. Five lysimiters with gradients varying from five to twenty percent were exposed to rainfall. Initially, applications of rainfall produced more erosion on the steeper gradients and less on the lower gradients. However, these rates of erosion were not constant throughout the period of rainfall. As the rain continued the amount of erosion was reduced until an equilibrium was reached and the rates of erosion from all gradients became approximately the same. This significant fact was attributed to the formation of an erosion pavement.

Thus, the erosion pavement, which is often noticeable on over-grazed areas or sloping hillsides, is evidence of accelerated erosion. In addition, it is a natural process which tends to equalize surface erosion on varying degrees of slope.

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- **MM** UNI-MOWER AND SIDE-MOUNTED MOWER
- **MM** WINDROWER
- **MM** SIDE-DELIVERY RAKE

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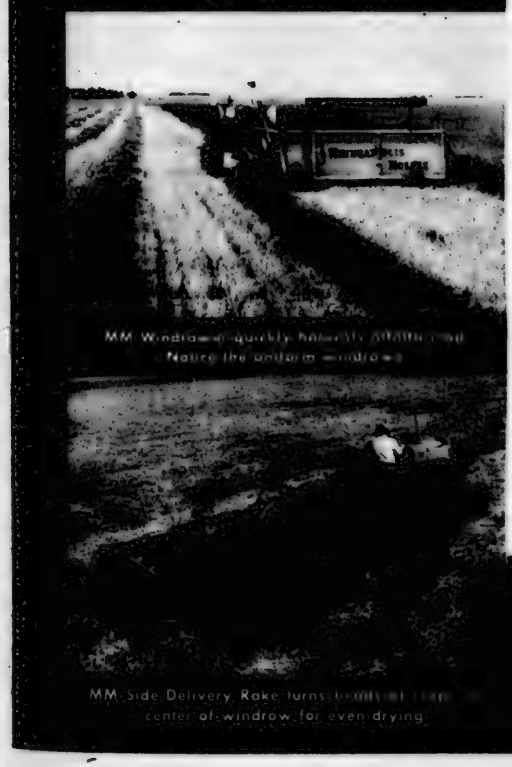
Modern HAY TOOLS . . .

. . . get the job done on time!

Quickly — Easily — Economically!

The pull-behind type MM Uni-Mower cuts up to 35 acres per day with 7 foot cuts.



MM Windrower quickly hair-dries alfalfa and leaves the perfect windrow.

MM Side Delivery Rake turns heads of crop center-of-windrow for even drying.

Lower Haying Costs!

MM HAY TOOLS GET ALL THE CROP ON TIME—EVERYTIME!! Every modern farmer knows that his hay crop is one of the most important crops on his farm. He knows that timely cutting of that crop is a most important factor in deciding its quality, and therefore its feeding and market value. Care must be taken to avoid cutting too early and also against allowing the crop to stand until full bloom has occurred and the nutrient value has begun to decline. Progressive farmers have learned that when they use MM Hay Tools their crop is cut right, on time, everytime.

MM UNI-MOWER is important to the haying time factor. This mower attaches to any modern tractor equipped with power-take-off. Equipped with a 7-foot cutting bar it *cuts up to 35 acres per day.* Since the power drive consists of a simple V-belt pulley, the sickle speeds can be easily changed to meet all cutting conditions . . . no gears to adjust and fewer wearing parts. MM Uni-Mowers are available in *pull-behind* and *side-mounted models* . . . mowers that allow farmers to spend less time in the field . . . mowers that are ready to cut the crop when it is *just right!*

MM SIDE-DELIVERY RAKE'S GENTLE HANDLING HELPS RETAIN FOOD VALUE! That's why so many modern farmers prefer this rake. The rolling action of the rake turns the heads into the center of the windrow leaving heavy butt end of the stems out where they will dry faster. Heads and leaves dry slowly and stay on the stem. The whole windrow dries more evenly and in less time, so that hay may be taken up sooner after cutting. Therefore there is less chance of loss by storm, and hay is better because few, if any, of the leaves in which most of the food value is concentrated are lost by breaking or tearing.

MM BALE-O-MATIC MAKES BALING A ONE-MAN JOB! That's important to farm businessmen who want to save money on their haying jobs. This baler is completely automatic . . . picks up the hay, slices, and ties it into firm bales with two 14-gauge high-tension steel wires while the hay is under compression. Bale-O-Matic bales are uniform, rectangular, square-cornered, and won't come untied when handling. No loose ends of wire left in the bales or in the field!

MM WINDROWERS CUT CROPS CLEANLY and deposit them in uniform windrows on top of the stubble. Even the finest hay seed crops are handled without injury. All controls are within easy reach of the operator, permitting easy change of cutting height and height of reel "on the go".

* QUALITY CONTROL IN MM FACTORIES ASSURES DEPENDABLE PERFORMANCE IN THE FIELD!

MINNEAPOLIS-MOLINE

MINNEAPOLIS 1, MINNESOTA

Flood Frequencies and Sedimentation from Forest Watersheds. *By* ANDERSON, HENRY W. *1949. Trans. Amer. Geo. Union 30(4): 567-584 Aug.*

The author uses a statistical approach for evaluating the variables effecting flood frequencies and sedimentation.

By multiple correlation and regression analysis of 127 sets of storm data for 29 watersheds in Southern California, the author determined six variables which were highly significant in effecting peak discharge. The relationship between sedimentation and three variables was also determined using statistical methods.

This approach is useful where sufficient hydrologic records are available. By analyzing existing data, the major factors influencing flows and sedimentation can be determined. This information can serve as a basis for determining what the upstream remedial program should be and for estimating the beneficial effects of such a land use program.

—*Contributed by* SIDNEY E. WEITZMAN

Getting Conservation on the Land Through Neighbor Groups

Technicians representing the Soil Conservation Service assigned to the Mason County Soil Conservation District, Scottville, Michigan, have been assisting farmers develop conservation farm plans through neighbor groups for the past few years with good results. After observing the results of these planning meetings, they began to wonder if servicing could not be conducted through neighbor groups. Mr. William Brozzo, conservaiton aid assigned to the Mason District, with the help of the county agricultural agent, developed the following procedure, which he has used with exceptional results in his servicing program:

Step 1. The neighbor group leader is contacted and a date set for a meeting of his group. He also notifies the individual members and assumes the responsibility of having each landowner bring his conservation farm plan to the meeting. The leader then opens the meeting with a friendly welcome and introduces the technicians, county agent, and others that may be present. This is followed by an explanation of the purpose of the meeting.

Step 2. Local slides of conservation practices that can and should be applied in the immediate area are shown, leaving ample time for the group to discuss each slide.

Step 3. Transparent tracing paper is passed out and each cooperator is asked to trace his farm boundaries and a few natural landmarks from his land use map. The cooperators are then asked to draw in field boundaries of current growing crops. Colored crayons are passed out and each field with row crops is colored red, small grain fields colored yellow, meadows colored green, and conservation practices applied in blue.

Step 4. Another sheet of transparent tracing paper is handed out. Each cooperator is then asked to trace his farm and field boundaries as they appear on his land use map. All planned conservation practices as they appear on the land use map should also be copied. Referring to the cropping sheet and using the same color scheme as in Step 3, each field is colored to indicate the planned use for that field for the coming crop year.

Step 5. The next step is similar to Step 4, only this time they will outline a map showing what they intend to do the coming crop year.

Step 6. Cooperators then determine seed, lime and fertilizer requirements for the coming year. In concluding, dates for establishment of various conservation practices during the current year are scheduled.

After using this system for a year we can point to the following advantages:

1. The rate of servicing was increased over the individual procedure. Following the individual contact procedure, it took 58 man days to contact 156 cooperators. Under the group system, 102 cooperators were contacted, in 9 man days.

2. It offers an opportunity to learn what the actual work load is for the coming year on each farm and to develop a schedule for follow-up purposes.

3. The cooperators do most of their own work towards studying and better understanding their individual conservation farm plans.

—LINDO J. BARTELLI, *Ludington, Michigan*

From Our Readers—

Dear Mr. Gumbel:

Thank you very much for sending the copy of the JOURNAL OF SOIL AND WATER CONSERVATION that contains Mr. Mendenhall's thoughtful and useful review of *Trees*. Many reviews generalize that the book is good or monumental or something else, but the review I like is the one that gives criticism and shows ways to improve it.

You are doing a wonderful job on the JOURNAL. I read it with intense pleasure and profit at least four times a year, and wish each time that it came oftener.

—AFRED STEFFERUD, *Editor, U.S.D.A., Yearbook*

New Mexico Going Strong

Gentlemen:

Farmers and ranchers, 713 of them in one district, have we soil conservation fellows with our backs to the wall at this time. That is the way we like to play the conservation game. We hope they will keep up their present interest.

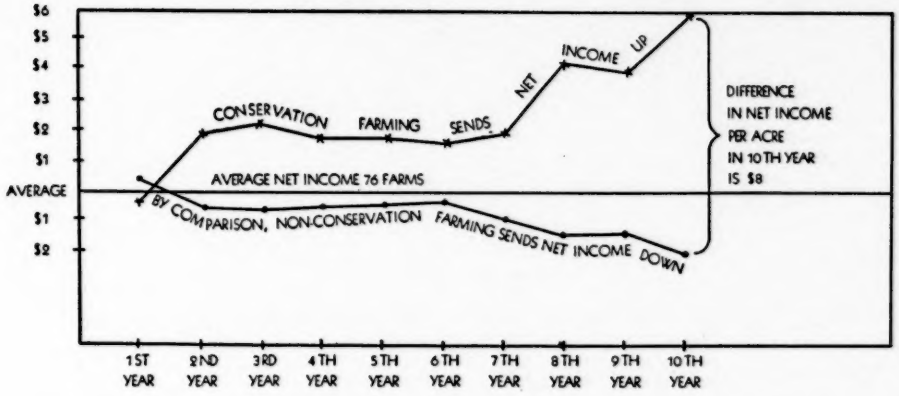
May we congratulate you fellows on the fine JOURNAL.

—HERBERT CAVETT, *Portales, N. M.*

Correction—January Issue

The photograph appearing on page 25 of the January issue of the JOURNAL was mis-captioned. It should read "An unusual picture of a flight of Canadian Geese over Tule Lake . . ." rather than "ducks."—EDITOR.

An EASY LESSON in HARD FACTS



The chart above demonstrates this plain fact: *Net income per acre usually goes up with conservation farming, down with non-conservation farming.* It's as simple as that.

Farmers' Own Story. **The chart tells a story, proved over a 10-year period, by carefully-kept farm record books on several hundred Illinois farms. From them, come these hard facts to make an easy lesson in soil conservation:**

1. **The straight line in the chart represents the average net income per acre of a number of farms involved, year by year, in a single county.**
2. **The upper zig-zag line shows the progressive increase in net income per acre, on 20 conservation farms in the county.**
3. **The lower zig-zag line represents the extent to which 20 physically comparable non-conservation farms in the same county fell below the over-all average (net income per acre on the farms involved).**
4. **Increases in income from conservation practices tend to be small at first—note upper zig-zag line from second to sixth year. Later on, they tend to rise abruptly—note upper zig-zag line from seventh to tenth year.**
5. **Meanwhile, in relation to the over-all average net per acre, non-conservation farmers (lower zig-zag line) earn less and less. They do not *necessarily* lose money, but if they make a profit, they do so by mining their land. Their soil grows progressively less productive.**
6. **The money-making practices in a complete conservation farm plan are really very simple: proper land use; testing and treating the soil; crop rotations with ample use of grasses and deep-rooted legumes; and (where needed) proper water management practices—in other words, soil conservation methods, which are available through the help of local authorities.**
7. **At the end of 10 years, as the chart shows, such practices were good enough to earn these Illinois conservation farmers $8 more net income per acre than the non-conservation farms earned.**

We believe that stories like this are a powerful argument for conservation farming. We urge you to keep on *telling them* and *selling them.*

John Deere

MOLINE · ILLINOIS

Above data based on Cooperative studies by the Agricultural Economics Department, University of Illinois, College of Agriculture and Economic Research Section of the Soil Conservation Service, U. S. Department of Agriculture, E. L. Sauer, Project Supervisor.

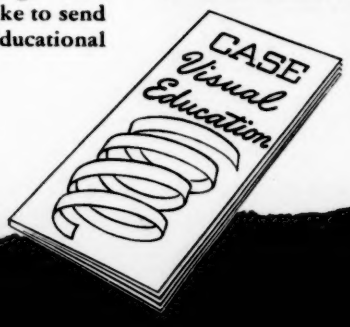
First Cousin to the Forest

Forests were to be fostered for their own sake, as sources of timber, in the dawning idea of conservation. Soon came consciousness of the forest role in control and conservation of water. Later was learned the power of trees in the toughest tasks of soil erosion and silt control.

Now we see that conservation comes not in closed compartments, but as a unified program of land utilization. Valley and hill, forest and field, wild life and farm livestock —all are parts of the intricate, interlocking pattern.

Farming methods play the dominant role in the agricultural aspects of conservation. Adoption and success of proper farming methods depend on availability and proper use of farm implements and machines. For more than a century, providing ever-better farm machinery has been the business of the J. I. Case Co. And increasingly, for many years, Case has carried on educational work to inspire farming methods that conserve soil and water as well as human time and toil.

As materiel for conservation methods, farm machinery is kin to the forest. As a contribution to closer kinship between leaders in forestry and agriculture, Case invites you to see . . . and to use, as you can . . . the Case educational materials. They cover all the accepted soil and water conservation practices from ponds to pastures . . . grassland farming and forage feeds . . . improvement of farm fertility and farm earnings.

There are movies in full color and sound . . . bulletin-style booklets . . . wall hangers and charts. All are listed in a little catalog, "Case Visual Education Materials." We'd like to send you a copy. Address J. I. Case Co., Educational Division, Racine, Wis.

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